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Forgo et al.

[11] **3,875,320**

[45] **Apr. 1, 1975**

[54] **PROCESS FOR ELECTROSTATIC PRINTING, PRODUCTS PRODUCED BY SUCH PROCESS, AND USE OF THESE PRODUCTS**

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Aug. 16, 1971 Switzerland 12104/71

[52] **U.S. Cl.** ..... **427/19,** 96/1 SD, 101/DIG. 13, 118/637, 235/58 P, 235/58 PS, 317/262 A, 346/74 ES, 355/3 DA, 355/17

[51] **Int. Cl.**...**G03g 13/08,** G03g 13/22, G03g 15/08, G03g 15/22

[58] **Field of Search** ..... 117/17.5; 96/1 R, 1 SD; 355/3, 17; 346/74 ES; 317/262 A; 118/637; 101/DIG. 13; 235/58 P, 58 PS

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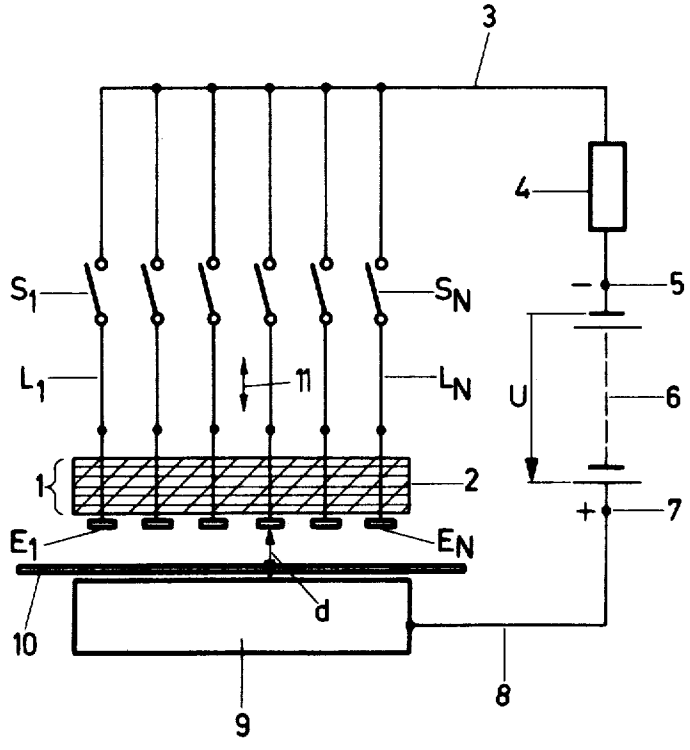
Attorney, Agent, or Firm—Werner W. Kleeman

[57] **ABSTRACT**

A process for producing printed images according to electrostatic printing techniques wherein at least during a portion of the time when a latent electrostatic charge image is produced at a carrier by means of a discharge operation occurring at an electrode arrangement there is carried out between the electrode arrangement and the carrier relative movements in alternate direction with movement components substantially parallel to the plane of the carrier.

27 Claims, 7 Drawing Figures



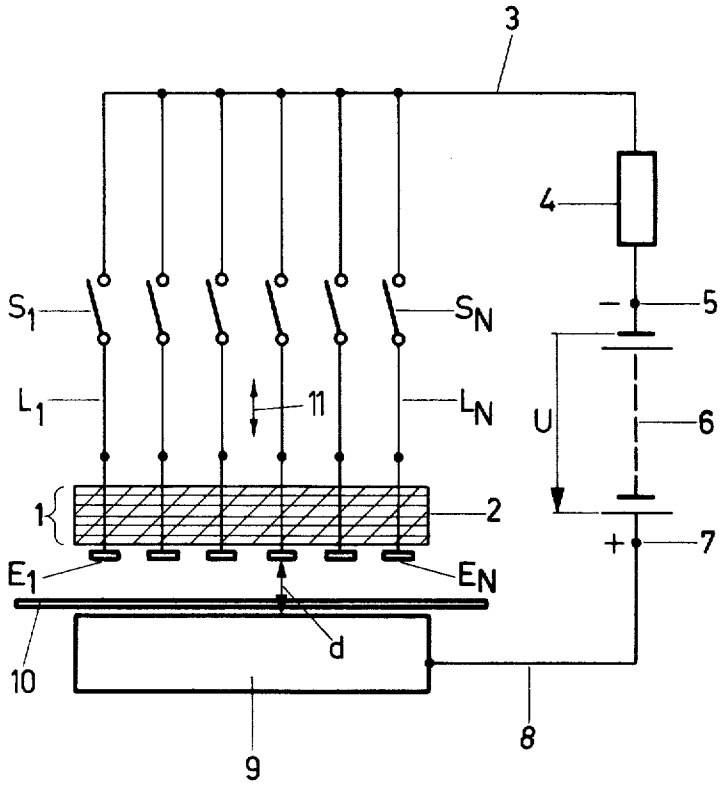


Fig.1

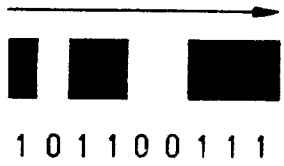
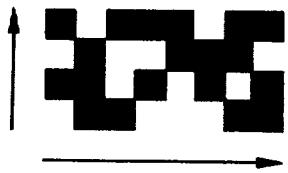


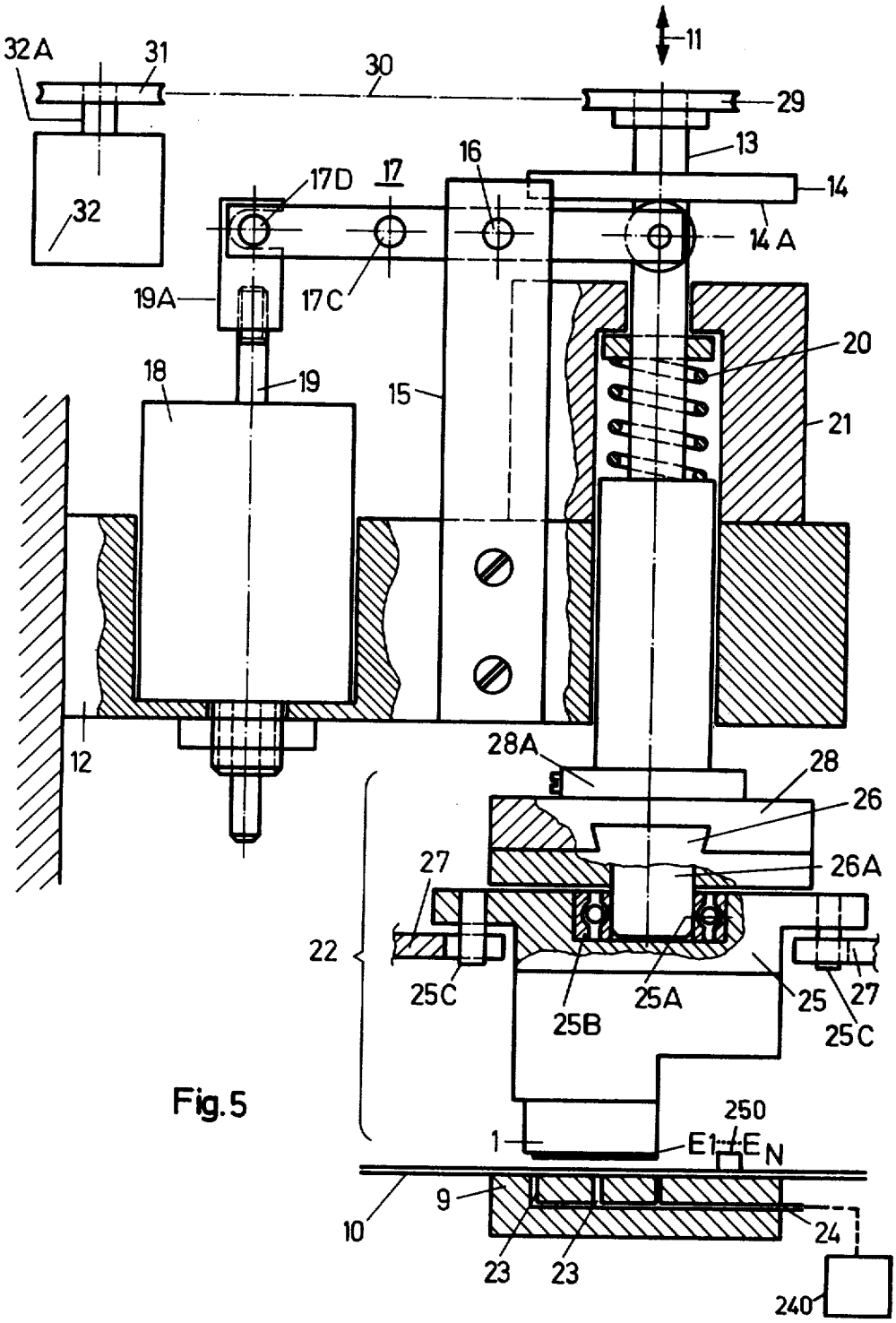
Fig. 2



1 0 1 1 1 0 1 1
0 1 0 0 1 1 1 0
1 1 0 1 0 1 0 1
0 1 1 0 0 0 1 1

Fig. 3

Fig. 4


32A
31
30
11
29
13
16
17D
17
14
14A
32
19A
17C
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18
19
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21
12
28A
28
26
27
26A
22
25C
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25
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25C
250
1
E1
EN
9
10
24
23
23
240

Fig.5

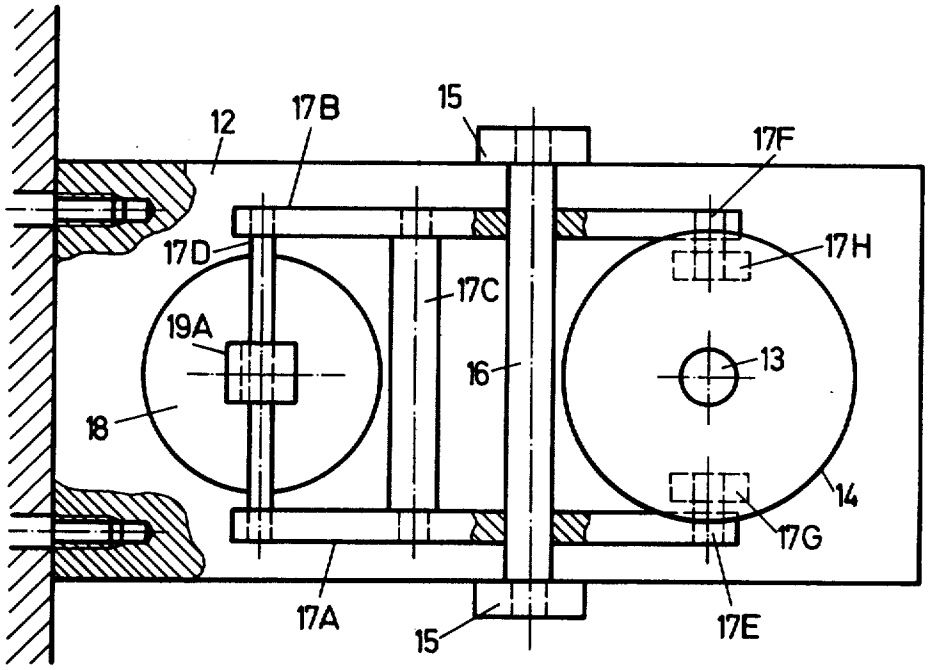
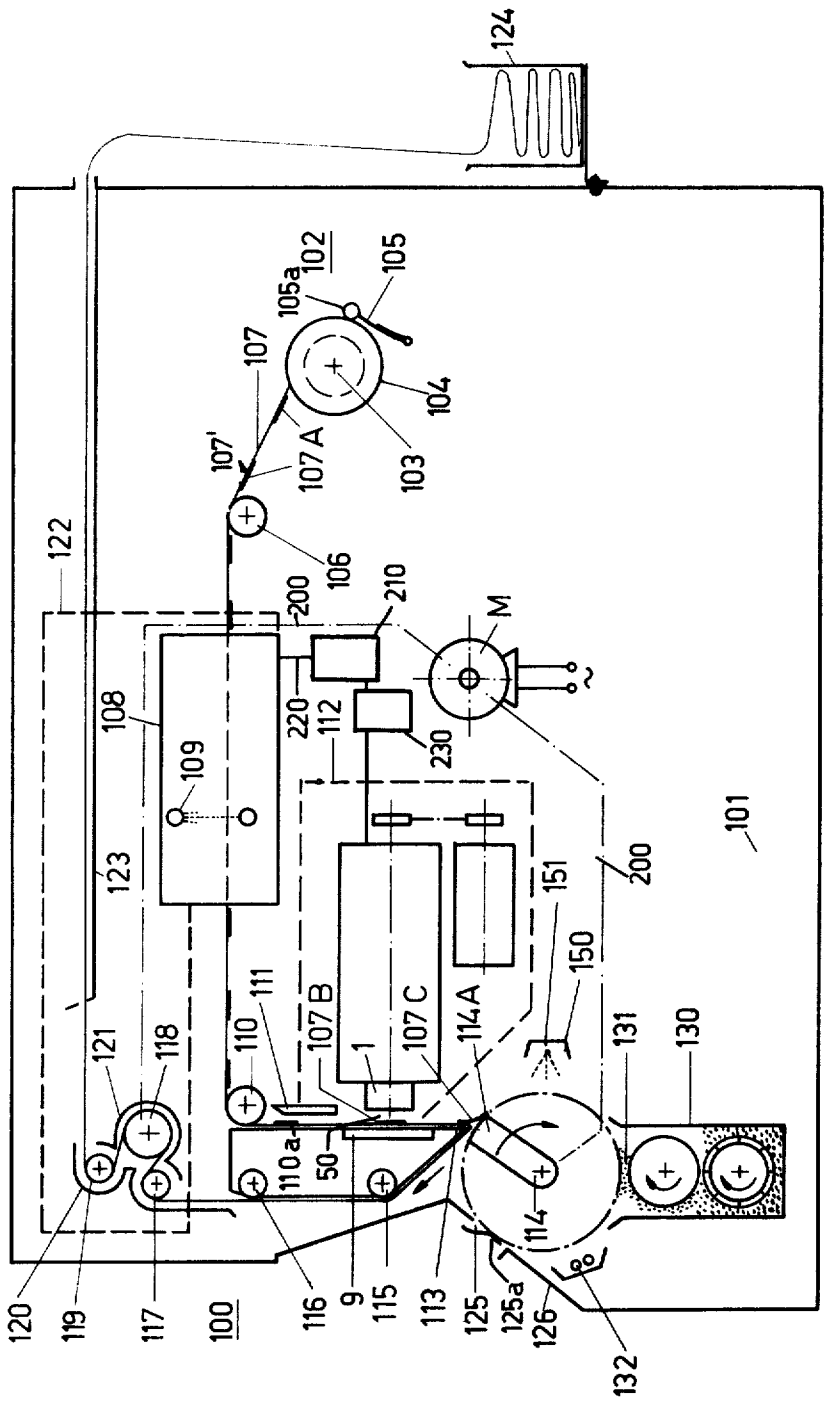


Fig. 6


124
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105a
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123
101
200
151
150
111
107B
107C
114A
131
130
110
1
121
118
110a
50
114
120
119
117
100
116
9
115
113
125
125a
126
132

Fig. 7

PROCESS FOR ELECTROSTATIC PRINTING, PRODUCTS PRODUCED BY SUCH PROCESS, AND USE OF THESE PRODUCTS

BACKGROUND OF THE INVENTION

The present invention relates to a new and improved process for electrostatic printing, products of the process as well as the use of the products produced by such process.

The invention is particularly concerned with a process for electrostatic printing in which a latent electrostatic charge image is produced at a carrier having a very high-ohmic layer by a discharge process from an electrode arrangement neighboring the carrier, wherein the electrostatic charge image subsequently is developed according to known techniques. These procedures are known and equipment for the performance thereof have been also described in publications. Although such known techniques are extremely outstanding as concerns the speed of their capability of producing the printed image and also as concerns their speed as concerns the variation possibilities of the printed images produced thereby, as such techniques are employed in different fields of application, such as for instance the conversion of digital computer output signals into clear text and the like, still they are nonetheless not suitable for the production of certain type of printed images. In particular, they are not suitable for instance for the production of printed images wherein the line traces or surface elements thereof, depending upon the configuration of the printed image, are disposed close to one another in such a manner that no gaps or spaces appear therebetween. This situation arises, for instance, in the case of code or coded images, hereinafter simply referred to as code images, as such are employed for example for marking articles, especially articles of sale.

Such code images which, for instance, can be in the form of a beam code, a checkerboard-like code pattern, a ring structure or the like, are read-out for evaluation purposes by means of a photoelectric reader. The thus obtained electrical pulse sequence or pulse train then corresponds to the sequence of light and dark locations of the scanned code image. Since the light spot employed for photoelectric scanning must possess very small dimensions, for instance fractions of a millimeter, in order to realize high definition or resolution, the aforementioned gaps or spaces between successive black code elements at the code image can produce erroneous pulse sequences. In order to prevent such type defective pulses or erroneous pulse gaps at the pulse train of the photoelectric reader it is necessary that the line traces or surface elements of the code image to be read-out closely follow one another. This is not so in the case of known electrostatic printing equipment destined for alpha-numerical characters.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide a new and improved process for electrostatic printing in which the drawbacks of the state-of-the-art proposals no longer occur and wherein it is possible to carry out printing of the surface elements or the like of the printed image in a manner such that they follow one another in succession without intermediately disposed gaps or spaces.

Yet a further significant object of the present invention relates to an improved process for electrostatic printing allowing for the production of clearly discernible electrostatic printed images in a highly reliable, accurate and efficient manner, so that read-out of such images is possible without error.

A further significant object of this invention concerns improved electrostatic printed products, typically labels, fabricated in accordance with the process aspects of the invention and by means of the inventive equipment.

A further object of the invention relates to the use of these fabricated products as markers, typically labels, for marking articles, especially articles of sale.

Now in order to implement these and still further objects of the invention, which will become more readily apparent as the description proceeds, the inventive process for the production of printed images according to electrostatic printing techniques is manifested by the features that at least during a portion of the time-span when there is formed at a carrier a latent electrostatic charge image by virtue of an electrical discharge operation emanating from an electrode arrangement, there is carried out between the electrode arrangement and the carrier relative movement in alternate directions with movement components essentially parallel to the plane of the carrier.

As already indicated above, the invention is also concerned with an improved apparatus for the performance of the aforementioned process and which is generally manifested by the features that there is provided a guide arrangement for the aforementioned electrode arrangement and/or the aforesaid carrier or the counterelectrode serving as its support, this guide arrangement allowing for a relative movement in alternate directions with movement components substantially parallel to the plane of the carrier between the electrode arrangement responsible for the production of the latent electrostatic charge image and the carrier provided for the reception of such latent electrostatic charge image.

The invention is also concerned with products, and particularly labels produced in accordance with the aforementioned process, and the use of the thus produced label products for marking articles, especially articles of sale.

The terms "carrier" or "label" as used in the context of this disclosure, are not to be considered in a limiting sense, and in fact are intended to conveniently denote almost any type of printable matter suitable for the purpose of the invention at which an image can be formed by electrostatic printing. Similarly, the term "article of sale" is used broadly to cover not only articles which are actually sold, but any type of article, whether sold or not, and intended to be identified by such "label."

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. 1 is a schematic electrical circuit diagram of a first exemplary embodiment of the invention;

FIG. 2 illustrates a code image in the form of a beam code;

FIG. 3 illustrates a code image having a checkerboard-like pattern;

FIG. 4 illustrates a code image in the form of a ring structure;

FIG. 5 illustrates details of the mechanical construction of an embodiment of the invention in side elevation;

FIG. 6 illustrates in plan view portions of the arrangement of FIG. 5; and

FIG. 7 schematically illustrates an embodiment of electrostatic printing apparatus in its entirety.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Prior to describing the exemplary embodiments of the invention on the basis of the drawings, there will initially be considered more fully the basic principles of this development.

In the practice of the present invention there is initially produced by an electrical discharge a latent electrostatic charge image which corresponds to the printed image to be produced, this electrostatic charge image being subsequently developed, for instance dry developed by means of a so-called magnetic brush for the application of a toner. What is considered to constitute a novel aspect as concerns the present invention relates to the particular manner of producing the latent electrostatic charge image. Such latent electrostatic charge image is produced as a consequence of a discharge phenomena which occurs between an electrode arrangement and a counterelectrode at a carrier, e.g. label having a relatively high-ohm layer and which is arranged in the space or region between the aforementioned electrode arrangement and counterelectrode. A discussion of the general technique of producing such electrostatic images can be found, for instance, in the publication known as Taschenbuch der Nachrichtenverarbeitung, Karl Steinbuch, Second Edition, 1967, Springer Publishers of Berlin/Heidelberg/New York, Library of Congress Catalog Card No. 67-21079, pages 696 et seq., FIGS. 5.7/5 and associated text.

By means of a selector, the different individual electrodes of the electrode arrangement have applied thereto different potentials so that there can be produced at a neighboring carrier a latent electrostatic charge image possessing a predetermined structure corresponding to the electrode arrangement and the voltage applied thereto.

The electrode arrangement and the individual electrodes thereof responsible for the production of a charge image of a predetermined configuration and which are to have the voltage applied thereto are connected with one pole of a voltage source through the agency of an external current circuit which contains the selector (discussed in the aforementioned publication) for the electrostatic charge image to be produced. The counterelectrode is correspondingly connected with the other pole of the voltage source. Depending upon the desired polarity of the electrostatic charge image to be produced which, in turn, is dependent upon the polarity of the subsequently employed developer, the electrode arrangement is connected with the positive or negative pole of the voltage source. There can be employed a purely direct-current voltage or a pulsating direct-current voltage. The amplitude of such voltage preferably amounts to about 450 to 1,000 volts.

For current limiting purposes after initiating the discharge operation it is advantageous to design the external current circuit leading to the electrodes so as to be relatively high-ohmic. A resistance value in the order of about 1,000 kilo-ohms has produced good results. Those individual electrodes of the electrode arrangement from which no discharge occurs to the carrier and through such to the counterelectrode, for the purposes of producing a certain charge image of a prescribed configuration, are advantageously galvanically connected with a point of considerably lower potential than the remaining individual electrodes furnished with voltage. They are preferably galvanically connected with the counterelectrode. This galvanic coupling can be thus advantageously selected to be very-high ohmic, for instance resistance values in the order of magnitude of approximately 10 megaohms to 100 megohms have produced good results.

Control of the selector for the selective coupling of each of the individual electrodes of the electrode arrangement with the voltage source or power supply can be undertaken both manually, for instance by actuating push button switches, as well as also with the aid of known electronic switching circuit arrangements.

Hence, it is possible for instance to introduce a pulse sequence characterizing certain data or information to be represented in the form of a printed image, into a shift register having a suitable number of counting stages. Following the input of the complete pulse sequence or pulse train into the shift register, there then appear at transverse outputs of the individual shift register stages logical signals, by means of which it is possible in each instance to actuate a switch, for instance designed as a Reed relay, associated with one of the relevant stages of the shift register and the associated individual electrode of the electrode arrangement. In this way there can be produced a latent electrostatic charge image which corresponds to the aforementioned pulse sequence and the information to be expressed thereby. Following development of such electrostatic charge image, there is obtained in the aforementioned manner a code image characterizing such information. Such has been discussed more fully in, and circuitry suitable for this purpose has been disclosed in, the commonly assigned, copending United States application, Ser. No. 272,111, filed July 17, 1972, entitled "Method For Marking Articles of Sale And Apparatus for the Performance of the Aforesaid Method," to which reference may be readily had.

Now with the benefit of the foregoing background in mind, and turning attention initially to the arrangement of FIG. **1**, there is shown therein a principle electrical circuit diagram of a first exemplary embodiment. An electrode arrangement **1** possesses N-number of individual electrodes $E_1 \ldots E_N$ individually connected in insulated fashion to a base plate **2**. Leading from each individual electrode $E_1 \ldots E_N$ is a conductor $L_1 \ldots L_N$ to each pole of a switch $S_1 \ldots S_N$. The relevant other pole of each such switch is connected to a conductor **3** which leads via a resistor **4** to a pole **5**, for instance the negative pole of a suitable voltage source **6**. This voltage source **6** has a terminal voltage U of, for instance, 750 volts direct-current. The other pole **7**, in this instance the positive pole, of such voltage source **6**, is connected through the agency of a conductor **8** with a counterelectrode **9** spaced at a distance *d* from the electrode arrangement **1**. In the intermediate space

between the pair of electrodes 1 and 9 i.e. the electrode arrangement 1 and the counterelectrode 9 there is located a carrier 10 for reception of the latent electrostatic charge image. Carrier 10 is advantageously snugly or tightly disposed upon the counterelectrode 9. Electrode arrangement 1 is mounted in a guide arrangement which has not been particularly illustrated in FIG. 1, but will be discussed more fully hereinafter in connection with FIGS. 5 and 6, and in such a manner that it can be displaced parallel to the plane of the carrier 10.

The switches $S_1 \ldots S_N$ can be manually actuated by push buttons or keys or, as already mentioned, there can be provided for this purpose for instance Reed relays or the like which can be controlled by means of an electronic control circuit. These switches $S_1 \ldots S_N$ together with a possibly provided control circuit form a selector circuit for the selection of the individual electrodes of the electrode arrangement to which voltage is to be applied for producing a certain configuration of the electrostatic charge image. In this regard reference is again made to our aforementioned copending application.

Now during the production of special printed images, especially coded images, according to the described procedures, certain difficulties arise.

In order to better understand the invention, there will now hereinafter be explained the particular problems which should be solved during the printing of such code images or characters. FIGS. 2, 3 and 4 illustrate therein different exemplary types of code images as such can be employed for instance for the marking of different types of articles or objects. FIG. 2 shows a beam-type code, FIG. 3 a checkerboard type code image, and FIG. 4 a code image having a ring structure, for instance formed of a series of concentric rings or otherwise. Of course, other configurations of the code images can be obviously employed without departing in any manner from the scope and teachings of the invention. By means of these code images it is possible to portray significant information, such as for instance the article number of the relevant goods, the price and other sales data in binary fashion. A black surface element, that is to say, a beam, square or ring, can for instance portray the binary value 1 and a white surface element of similar configuration can signify the binary value O. It is possible for both black and white surface elements to directly follow one another. For the automatic electro-optical reading of such coded images, a light beam is delivered in known manner parallel to or in the indicated direction of the arrow or arrows across the code image and the periodically reflected light is converted by a photoelectric transducer into a sequence of electrical pulses. The technique of reading-out the code characters or coded markings constitutes subject matter of other applications assigned to this assignee and is not necessary for the understanding of the underlying concepts of this development and therefore will not be considered in any greater detail herein.

Yet it is to be mentioned that for the purpose of avoiding erroneous reading or read-out results, it is necessary that between directly following or successive black surface elements, in other words, for instance directly successively following black surface elements which represent a binary value 1, there does not occur any white gaps or spaces since such could at least briefly simulate a binary value 0. This problem does not arise in alphanumerical representations because in that situation the individual characters are anyway separated from one another by a more or less wide gap.

The individual electrodes $E_1 \ldots E_N$ (FIG. 1) of the electrode arrangement 1 required for producing one of the aforementioned code images or its surface element respectively, considering the normally small spacing d, of, for instance, several tenths of a millimeter between such individual electrodes $E_1 \ldots E_N$ of the electrode arrangement 1 and the carrier 10, according to experience which has been gained with the known prior art equipment must be chosen to be approximately of the same size as the surface element of the latent electrostatic charge image which is to be produced and the code image which should be recognized following development thereof. If it is desired to be able to use all of the surface elements of the code character in a random sequence, thus for instance the binary character sequence 0000 or 1111 or 0101 or 1010 or 0110 or 1001, then it should be apparent that at least for part of the aforementioned situations there must be produced in direct succession black surface elements, but for another part of the aforementioned situations there must be produced at the same location different characters, in other words black or white characters. Since for initiating the discharge required for the formation of the electrostatic charge image only those individual electrodes which are associated with the black surface elements of the code image are to be connected with the voltage power source, it should be recognized that between the individual electrodes $E_1 \ldots E_N$ there must be provided an insulation which is sufficient for the full voltage, for instance approximately 750 volts. Since, however, according to what has been previously stated the individual electrodes are to be chosen to be approximately of the same size as the surface elements of the electrostatic charge image to be produced or the code image respectively, it should be apparent that in order to apply a sufficient insulation between the individual electrodes there is just not available the necessary space.

Moreover, even if for instance there is required and used an insulation of, for instance, only 0.2 millimeters, then still such results in the fact that between the surface elements of the electrostatic charge image gaps or spaces would appear which, after developing of the code image would produce white gaps or spaces between directly successively following black surface elements. These white gaps or spaces could, however, render questionable the reliable electro-optical read-out of the code image.

Now according to an advantageous manifestation of the invention and for the purpose of overcoming the aforementioned problem, the electrode arrangement 1 is formed of individual electrodes $E_1 \ldots E_N$ which possess a considerably smaller dimension in the read-out direction or read-out directions of the code image produced thereby than the surface elements of the electrostatic charge image or code image which is to be produced by such electrode arrangement. The width of the individual electrodes can thus, for instance, amount to approximately one-half or one-third of the surface element at the charge image or code image which is produced by the individual electrodes. Now in order to be able to obtain surface elements of the full width at the charge or code image, notwithstanding the use of such small individual electrodes, it is contemplated to carry

out a desired displacement, for instance between the electrode arrangement **1** and the carrier **10** for the latent electrostatic charge image, at least during a portion of the time when such charge image is produced, and this displacement is undertaken essentially in the direction of the desired increase in size of the relevant surface element. Moreover, this displacement is advantageously undertaken in alternate directions. This displacement movement can, for instance, be carried out in the form of a to-and-fro movement if it is desired to form a code image of the type depicted in FIG. **2.** In the event it is desired to form a code image of the type depicted in FIG. **3** and if such code image is read-out in the lengthwise and transverse directions, then, there is employed a lengthwise- and transverse displacement during the production of the charge image. On the other hand, if it is desired to produce a code image of the type depicted in FIG. **4,** then it is advantageous to perform an eccentric circular movement in order that the rings are increased in size to the full desired size or width at each location. Preferably, there is not only employed a single to-and-fro movement or circular movement during production of the charge image, rather the relative movement which is carried out between the electrode arrangement and the carrier is repeated a number of times. The amplitude of the aforementioned relative movements can be advantageously selected so as to be even slightly larger than is absolutely necessary for producing the full nominal surface element width. By virtue of this feature it is possible to realize a slight overlapping of neighboring black surface elements, so that possible tolerances of the apparatus and/or those of the discharge operations can be compensated.

Since what is significant is the relative movement between the electrode arrangement and the carrier for the charge image or counterelectrode the apparatus for carrying out this technique can be designed, for instance, such that the carrier **10** is stationary and only the electrode arrangement **1** is displaced or vice versa, or in fact both the electrode arrangement and the carrier for the charge image can be displaced.

Owing to the aforementioned measures there is not only brought about a widening of the surface elements, but even more so the uniformity of the charge distribution within the individual surface elements of the charge image is considerably improved. In this way there is achieved the effect that the code image obtained after developing the charge image possesses a considerably better blackening of the surface elements than would have been possible without the aforementioned relative movement between the electrode arrangement and the carrier. This is of particular importance for the purpose of producing code images, since a uniform blackening of the black surface elements provides an improvement in the read-out integrity of the code image.

In FIG. **5** there is disclosed in side elevational view the mechanical construction of an exemplary embodiment of the invention, and in FIG. **6** there is disclosed in plan view portions of the arrangement of FIG. **5.** In all Figures corresponding components have been designated by the same reference characters.

A shaft or axle **13** is rotatably mounted at a carrier **12** which is rigidly secured to the entire frame or housing of the apparatus. The shaft **13** carries a belt pulley or pulley disk **29.** Pulley disk **29** can be driven by means of a schematically indicated belt **30,** and thus, shaft **13** can be rotatably driven by means of a drive motor **32** with the aid of the pulley disk **31** seated upon drive shaft **32A.** The belt **30** drivingly connects pulley disk **29** with the pulley disk **31.**

Additionally, a holder mechanism, generally indicated by reference character **22,** for the electrode arrangement **1** (FIG. **1**) is secured to shaft **13.** Opposite the electrode arrangement **1** there is located at a certain spacing *d* the counterelectrode **9.** Through this space or gap which possesses the height *d* there may be continuously or intermittently drawn, by means of suitable feed mechanism not particularly shown in FIG. **5** but like the feed mechanism **122** of FIG. **7** to be discussed later, the carrier **10** for the latent charge image which is to be imprinted thereat. The counterelectrode **9** is advantageously provided with bores **23** which are connected via a pipe or conduit **24** with a suitable controllable vacuum device **240** or other source of negative pressure for instance. In this way, and during the production of the electrostatic charge image, and owing to the action of the vacuum acting at the underside of the carrier **10,** this carrier **10** is fixedly retained in its momentary position against the counterelectrode **9.** With this exemplary embodiment given purely by way of illustration, both the carrier **12** as well as the counterelectrode **9** are rigidly connected in position at the entire frame or chassis of the apparatus. Further, if desired, a suitable carrier holddown mechanism, such as the schematically illustrated electromagnetically actuated clamping mechanism **250** can be provided, as indicated in FIG. **5.**

It is now to be assumed that with the apparatus according to the embodiment under consideration, code images of the type depicted in FIG. **4** are to be printed. The individual electrodes $E_1 \ldots E_N$ possess substantially semicircular-shaped configuration. They can be arranged for instance according to the technology of printed circuits, for example, upon an epoxy glass fiber plate. In order to increase the wear resistance they can be galvanically finished, for instance provided with a hard gold or rhodium coating.

The width of the individual ring-shaped electrodes $E_1 \ldots E_N$ is selected in consideration of the required insulation therebetween, thus for instance amounts to only 0.2 millimeters, whereas the spacing to the neighboring individual electrodes for instance can amount to 0.8 millimeters. In order to increase or widen the surface elements of the electrostatic charge image and the code image formed following development of such electrostatic charge image, the electrode arrangement **1** has imparted thereto and through the agency of an eccentric mechanism to be considered shortly a substantially circular-shaped displacement movement in a plane which is disposed perpendicular to the shaft **13.**

To this end the electrode arrangement **1** is secured to a guide element or piece **25.** This guide element **25** possesses a central bore **25A** in which there is inserted a ball bearing **25B.** An eccentric pin **26A** engages with such ball bearing **25B.** The guide element **25** is secured against rotation about the shaft **13** in that two guide bolts **25C** force fitted therewith engage with a respective bifurcated or fork-shaped stationary guide piece **27.** The opening of the fork portion and the diameter of the guide bolts **25C** are selected such that the guide element or piece **25** only carries out eccentric movements not however any rotation about the shaft **13.** The eccentric pin **26A** is part of an eccentric plate **26** which

is adjustably mounted at a counterpiece **28** in transverse direction with respect to the shaft **13.** This counterpiece **28** has a hub **28A** which is secured to the lower end of the shaft **13.**

With the shaft **13** rotating and depending upon the selected transverse displacement of the eccentric plate **26** at the counterpiece **28,** the eccentric pin **26A** carries out eccentric curcular movements which are imparted via the guide piece **25** to the electrode arrangement **1** connected therewith.

Tests have further shown that through variation of the spacing *d* between the electrode arrangement **1** and the counterelectrode **9** or the carrier **10** for the latent electrostatic charge image located therebetween, there can be additionally realized an improved quality of the printed image. It may be assumed that this improvement is brought about by virtue of a uniform charge distribution within the line traces or surface elements of the latent electrostatic charge image.

Thus, FIG. **5** also shows for an additional exemplary embodiment an advantageous further design of the invention. According to the illustration of FIG. **6,** the shaft **13** is not only mounted to be rotatable at the support or carrier **12** but can be also displaced in the direction of the double-headed arrow **11.** The shaft **13** carries a flange **14** with a contact or running surface **14A.** At both sides of the carrier or support **12** there is secured a respective bracket or support **15.** Between both of these brackets **15** there is connected a shaft **16** (FIG. **6**). A pivotal frame **17** is mounted for movement about this shaft **16,** the pivotal frame **17** embodying both of the pivot arms **17A** and **17B,** a first connection piece **17C** and a second connection piece **17D.** Each of the pivotal arms **17A** and **17B** carries at its right-hand end a force fitted journal or axle piece **17E** and **17F** upon which there is rotatably arranged a respective roller or roll **17G** and **17H** respectively.

Furthermore, at the carrier or support **12** there is secured an electromagnetic system **18** in such a manner that a traction or draw rod **19** comes to rest beneath the connection piece **17D.** A coupling element **19A** of the draw rod **19** is adjustably attached to this draw or traction rod **19.** The coupling piece **19A** engages at least partially about the second connection piece **17D** of the pivotal frame **17.** Upon excitation of the electromagnetic system **18,** its traction rod **19** is retracted downwardly, so that the pivotal frame **17** lowers at the left side of the shaft **16,** and at the right side thereof is raised. Owing to this movement, the rollers **17G** and **17H** press against the contact or running surface **14A** of the flange **14.** As a result, the shaft or axle **13** is displaced upwards. By means of a resilient element e.g. spring **20** arranged in guide housing **21** the shaft **13** is again lowered after switching-off or deenergizing the electromagnetic system **18.** Due to the action of the electromagentic system and the spring **20,** it is possible to thereby displace the shaft **13** in the direction of the double-headed arrow **11.**

The arrangement is constructed such that at least during a portion of the time span during which the discharge operation occurs for the production of the latent electrostatic charge image at the carrier **10** the spacing *d* is changed. This can be realized in that there is undertaken a periodic excitation of the previously non-energized electromagnetic system **18** and a periodic non-energization of the previously energized electromagnetic system **18** during the time span in which the discharge operation between the electrode arrangement **1** and the carrier **10** and the counterelectrode **9** is to be maintained.

It would also be conceivable, however, instead of or in addition to the movement of the electrode arrangement **1,** to move the carrier **10** and the counterelectrode **9** upon which the carrier **10** rests so as to realize the aforementioned change in spacing.

Now in FIG. **7** there has been schematically depicted the general overall arrangement of an electrostatic printing apparatus suitable for the practice of the invention and which has been conveniently designated in its entirety by reference character **100.** This electrostatic printing apparatus **100** is mounted upon a base plate **101.** Base plate **101** carries the individual cooperating components of the equipment as will be more fully discussed hereinafter. Various ones of the individual components thereof are driven, for instance, through the agency of a belt drive or a chain drive from a common drive motor M, as will also be explained hereinafter, and as indicated by the schematic drive connection lines **200** shown in the drawing.

The equipment under consideration will be understood to embody a supply device **102** for the markers or carriers, for instance in the form of the labels **107A** to be imprinted and carried by a carrier strip foil **107,** also merely referred to as a carrier foil. The supply device **102** incorporates a supply roll **104** rotatably mounted upon a fixed shaft or axle **103.** Supply roll **104** is braked by a suitable braking mechanism **105,** for instance through the action of a spring-loaded braking roll **105a** acting upon the periphery of supply roll **104,** in such a manner that the carrier foil strip **107** which moves over and away from a deflecting roll **106** can be tautly withdrawn from the supply roll **104.**

The carriers to be imprinted, for example the labels **107A,** are applied to the carrier foil strip **107** at a certain spacing from one another. Carrier foil strip **107** may constitute an impregnated paper strip, a paper strip with a metallic coating applied thereto by vapor deposition or otherwise, or such carrier foil strip can comprise a metallic foil strip. These labels **107A** may advantageously be equipped with a self-adhering layer or coating, as schematically indicated at **107',** such that they adhere to the carrier foil strip **107** with just such intensity that they can be conveyed thereon through the printing apparatus without prematurely falling-off such carrier foil strip **107** during transport. Yet it would also be possible to employ a carrier foil strip which itself has an adhesive layer and at which there is adhesively applied the labels which themselves are not adhesive. It should be understood that the invention is not generally restricted to any specific type of carrier foil strip and electrostatically printable label, since the practice of the particular development of the invention disclosed herein affords the use of many different possibilities for such carrier foil strip and labels. By way of completeness it might be indicated that suitable constructional forms of carrier foil strips and markers (labels) to be imprinted adhering thereto have been disclosed, for instance, in the commonly assigned, United States application Ser. No. 225,111, filed Feb. 10, 1972, and entitled "Laminated Papers," listing as the inventor Arnold Hofer, and also in the commonly assigned United States application, Ser. No. 263,671 filed July 16, 1972, entitled "Laminated Article," and listing

as the inventor Walter Strohschneider to which reference can be readily had.

Irrespective of the type of carrier foil strip or label which is employed the carrier foil strip **107** is then caused to travel through a suitable control mechanism **108** of a strip feed mechanism **122.** Although the invention is not intended to be limited to any specific construction of control mechanism **108,** it can for example contain means, such as photoelectric means **109,** a light barrier for instance, acted upon by the labels **107A** adhering to the carrier foil strip **107.** The labels **107A** are either blank, that is non-printed, or they can already contain imprinted thereon a pre-printed text, common to all of the labels, for instance data pertaining to a company, or pre-printed subject matter for the data pattern or the like which later is to be electrostatically imprinted. Moreover, special markings of such pre-printed matter or the edge of the labels themselves could be conceivably employed as criteria for triggering operation of the photoelectric means **109.**

The feed mechanism **122** may be controlled in any suitable manner such that, for instance, owing to the output signal of a conventional article weighing or balance device having an automatic data output, or a keyboard arrangement, it can be placed into operation, whereby it is subsequently again brought to standstill by the control mechanism **108** as soon as the next successive label at the carrier foil strip **107** has assumed the same position as the preceding label prior to placing into operation such feed mechanism. Details of a balance and keyboard arrangement for obtaining desired output signals have been disclosed in the aforementioned commonly assigned, United States application, Ser. No. 272,111, filed July 17, 1972, entitled "Method For Marking Articles Of Sale And Apparatus For The Performance Of The Aforesaid Method." Thus, the balance and/or keyboard arrangement has been simply designated by reference character **210** and its connection line with the feed mechanism by reference character **220.** As also disclosed in detail in such application the balance and/or keyboard arrangement **210** is connected with a suitable selector control circuit **230** for selectively controlling given electrodes of the electrostatic printer **112** in accordance with output signals from the unit **210** and characterizing significant information about the article to be marked, so as to produce a desired electrostatically charged image at the label. After departing from the control mechanism **108,** the carrier foil strip **107** together with the thereon adhering labels **107A,** travels over a further deflecting roll **110** through a slot **110a** beneath a guide plate **111** of the electrostatic printer or printing mechanism **112.** The construction and mode of operation of the electrostatic printer **112** has already been described in conjunction with FIGS. **1, 5** and **6.**

At this point it is mentioned that owing to stepwise actuation of the feed mechanism **122,** a label **107B** which is in transit is brought into a predetermined position at a gap or slot **50** between the electrode arrangement **1** and the counterelectrode **9.** By applying a suitable voltage, for instance 750 volts, between the components of the electrode arrangement **1** and the counterelectrode **9** an electrical discharge occurs therebetween, so that a latent electrostatic charge image is produced upon label **107B.**

Now the feed mechanism **122** further advances the carrier foil strip **107,** whereupon such travels over a sharp deflecting edge or turning location **113** and over further deflecting rolls **115, 116, 117,** then about a feed roll **118** and a further deflecting roll **119.** The indexing of the feed steps and the spacing of the individual labels **107A** upon the carrier foil strip **107** are selected so as to be of a magnitude sufficient that, on the one hand, the label which has now been provided with the latent electrostatic charge image, owing to its greater stiffness in contrast to the carrier foil strip **107,** releases from such carrier foil strip at the edge **113** and, on the other hand, the next successive label at the carrier foil strip **107** then just assumes the prescribed position between the electrode arrangement **1** and the counterelectrode **9** as previously considered.

The label provided with the latent electrostatic charge image and which has been released from the carrier foil strip **107,** has been conveniently designated by reference character **107C.** A movable element or member **114,** for instance an intermittently or periodically rotating arm, a roller or equivalent device, and which receives at its end face of surface **114A** the released label **107C,** is located in the neighborhood of the sharp deflecting edge **113,** i.e. at the location where the label **107C** is released from the carrier foil strip **107.** In order to insure for proper transfer of the label it is possible to provide, for instance, a roller formed of insulating material and which presses with a slight pressure against the aforementioned end surface **114A.** This end surface **114A** or the entire movable element **114** is preferably fabricated from a material, for instance "TEFLON" or the like to which the self-adhering labels **107C** do not adhere too strongly.

The latent electrostatic charge image applied to the labels **107C** by means of the electrostatic printer or printing mechanism **112,** are later developed in a suitable developer or developing device **130.** This developer **130** produces a so-called magnetic brush **131.** The magnetic brush **131** contains numerous static electrically charged toner particles, the polarity of which is chosen to be opposite to the polarity of the latent electrostatic charge image. During the advancing movement of the labels **107C** during the rotation of the movable element **114,** toner particles from the magnetic brush **131** are attracted by the charged locations of the electrostatic charge image so that there appears a visible image. The developer may be for example of the type disclosed in the commonly assigned, copending United States application, Ser. No. 268,783, filed July 3, 1972, and entitled "Apparatus For Developing Latent Electrostatic Charge Images," now U.S. Pat. No. 3,783,828, granted Jan. 8, 1974 and to which reference may be readily had.

Preferably the side or face of the label **107C** impinged with the latent electrostatic charge image as it moves from the electrostatic printer **112** to the developer **130** is temporarily subjected to the action of a corona discharge from a corona discharge device **150** having an electrode **151,** this corona discharge having a polarity opposite to the polarity of the electrode arrangement **1.** As a result, the parts of the label which should remain white are charged opposite to the polarity of the electrostatic charge image. Although this charge is weaker than the charge at the latent electrostatic charge image this still insures that there will occur a repulsion of the charged toner particles from the locations of the label which should remain white. Owing to these measures the contrast of the electrostat-

ically produced printing image is considerably improved. Techniques and equipment for improving the contrast of the electrostatically produced printing image forms subject matter of the commonly assigned, copending United States application, Ser. No. 272,064 filed July 14, 1972, and entitled "Method And Apparatus For Improving The Contrast During Electrostatic Printing."

It is advantageous to deliver the developed image to a suitable fixing mechanism or fixer **132** in order that the image composed or relatively weakly adhering toner particles becomes wear or abrasion resistant. Such fixer **132** can be realized, for instance, by means of an infrared radiation device.

During further movement of the movable element **114** the label **107C** adhering thereto, the electrostatic charge image of which has now been fixed, is delivered to an opening **125** of the electrostatic printing apparatus **100.** The finished labels **107C** can be removed at that location from such electrostatic printing apparatus **100.** It is also advantageous at this location to allow a suitable stripper or gripper mechanism, for instance in the form of a fork-like stripper **125***a* or the like, to act beneath the finished label **107C** in order to facilitate removal of such label.

The carrier foil strip **107** which has been freed from the labels leaves the feed mechanism **122** through a channel or groove arrangement **123.** This carrier foil strip **107** can be collected for instance at a receptacle or container **124** mounted at the outer wall of the housing of the electrostatic printing apparatus **100.** It is however also possible to deliver the carrier foil strip **107** via the channel arrangement **123** to a wind-up mechanism so that such carrier foil strip can be again re-used. This can be advantageous if there is employed as the material for the carrier foil strip, for instance, a metallic foil or a metallized paper strip, the costs of which are significant, so that reuse is warranted.

The motor M arranged at the base plate **101** drives through the agency of chains or belt means and the like the strip feeder or feed mechanism **122** and the movable element **114.** This drive motor M can be also used for driving the developer **130.** The temporary connection of such system components with the drive motor M can occur in conventional manner by means of suitable electromagnetic coupling means, the excitation of which, for instance, can be controlled in any suitable way, as for instance through the use of a cam disk in well known manner.

While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

Accordingly, what is claimed is:

1. A process for producing printed images by electrostatic printing techniques, comprising the steps of producing a latent electrostatic charge image on a carrier by means of a discharge from an electrode means composed of individual electrodes, during at least a portion of the time span during which the discharge occurs for producing the latent electrostatic charge image on the carrier carrying out between the electrode means and the carrier relative movement in alternate directions with movement components essentially parallel to the plane of the carrier, producing by means of said relative movement in alternate directions occurring between the electrode means and the carrier a latent electrostatic charge image which is larger in size than the size of the width of the individual electrodes of the electrode means participating in the formation of such electrostatic charge image, and then applying toner to the thus produced electrostatic charge image to form a developed image, and fixing said developed image to said carrier.

2. The process defined in claim **1,** wherein said relative movement in alternate directions is achieved by maintaining the carrier stationary and moving the electrode means relative to the carrier.

3. The process as defined in claim **1,** wherein said relative movement in alternate directions is achieved by maintaining the electrode means stationary and moving the carrier relative to the electrode means.

4. The process as defined in claim **1,** wherein said relative movement in alternate directions is achieved by moving both the electrode means and the carrier.

5. The process as defined in claim **1,** further including the steps of changing the spacing between the electrode means and the carrier at least during a portion of the time the latent electrostatic charge image is formed.

6. The process as defined in claim **5,** further comprising moving the electrode means relative to the carrier to change said spacing.

7. The process as defined in claim **5,** further comprising moving the carrier relative to the electrode means to change said spacing.

8. The process as defined in claim **5,** further comprising moving both the electrode means and the carrier relative to one another to change said spacing.

9. The process as defined in claim **5,** wherein the relative movement in alternate directions takes place essentially simultaneously with the change in spacing between the electrode means and the carrier and in a direction substantially perpendicular thereto.

10. The process as defined in claim **5,** wherein the relative movement in alternate directions occurs at a different time from the time during which there occurs said change in spacing direction between the electrode means and the carrier and is carried out in a direction substantially transverse thereto.

11. The process as defined in claim **1,** further including the step of delivering the voltages necessary for producing the latent electrostatic charge image to the electrode means at least during a portion of the time span when there occurs the relative movement in alternate direction between the electrode means and the carrier.

12. The process as defined in claim **5,** further including the step of delivering voltages to the electrode means at least during a portion of the time span when there occurs said relative movement in alternate directions which is transverse to the direction of the change of spacing and at least during a portion of the time span when there occurs a change in the spacing between the electrode means and the carrier.

13. The process as defined in claim **1,** further including the step of providing an electrostatic printer, and stepwise moving the carrier to the electrostatic printer for producing a latent electrostatic charge image thereat.

14. The process as defined in claim **1,** further including providing an electrostatic printer, and continuously the carrier to the electrostatic printer for producing the latent electrostatic charge image.

15. The process as defined in claim 1, further including providing a corona discharge device, and moving the carrier into the operable region of the corona discharge device.

16. The process as defined in claim 1, further including the step of delivering the carrier containing the latent electrostatic charge image to a developer and following developing of the electrostatic charge image removing the carrier from said developer.

17. The process as defined in claim 16, further including the step of delivering the carrier with the developed electrostatic charge image to a fixer and following fixing of the developed electrostatic charge image withdrawing such carrier from the fixer.

18. The process as defined in claim 1, wherein the amplitude of said relative movement in alternate direction is at least so large that the surface elements of the charge image produced by neighboring individual electrodes of the electrode means abut one another essentially without any intermediate spaces.

19. The process as defined in claim 18, wherein said amplitude is of a magnitude such that said surface elements slightly overlap one another.

20. The process as defined in claim 1, further including the step of providing a manually operated control for the selection of given individual electrodes of the electrode means, and applying a voltage thereto for the initiation and maintenance of said discharge.

21. The process as defined in claim 1, further including the step of automatically selecting the desired individual electrodes of the electrode means to which there is to be applied a voltage for initiating and further maintaining the discharge operation.

22. The process as defined in claim 1, further including the steps of providing a balance device having an output signal, and automatically applying voltage to the individual electrodes of the electrode means for producing a latent electrostatic charge image as a function of an output signal from the balance device.

23. The process as defined in claim 1, including the steps of providing an electrostatic printer, and storing the carriers for the latent electrostatic charge image upon a carrier foil strip at a supply device and delivering such carrier foil strip with the carriers mounted thereon to the electrostatic printer.

24. The process as defined in claim 23, including the step of moving the carrier foil strip with the thereon adhering carriers for the charge image such that the next successive carrier at the carrier foil strip assumes the position previously occupied by the preceding carrier.

25. The process as defined in claim 23, further including the step of guiding the carrier foil strip about a sharp edge in such a manner that owing to the greater stiffness of the carriers in relation to the carrier foil strip a carrier is detached from the carrier foil strip at the region of said sharp edge, and thereafter delivering the carrier separated from the carrier foil strip to a developer for the development of the electrostatic charge image located thereon.

26. The process as defined in claim 25, wherein the carrier freed from the carrier foil strip is delivered to a predetermined location for purposes of re-use.

27. The process as defined in claim 1, further including the step of employing the carrier as a label for the marking of articles.

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