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Forgo et al.

[11] **3,861,940**

[45] **Jan. 21, 1975**

[54] **METHOD FOR ELECTROSTATIC PRINTING, PRODUCTS PRODUCED THEREBY, AND USE OF THESE PRODUCTS**

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[73] Assignee: **Zellweger AG,** Uster, Switzerland

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[52] **U.S. Cl.** ..... **117/17.5,** 96/1 SD, 101/DIG. 13, 118/637, 317/262 A, 346/74 ES, 355/3 DD, 355/17, 235/58 P, 235/58 PS

[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 R, 3 DD, 17; 346/74 ES; 317/262 A; 118/637; 101/DIG. 13; 235/58 P, 58 PS

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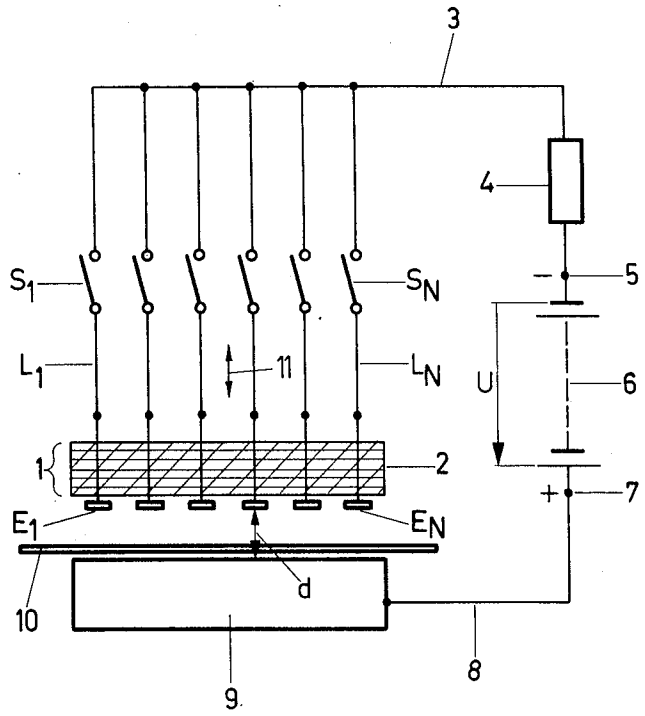
Attorney, Agent, or Firm—Werner W. Kleeman

[57] **ABSTRACT**

A method of producing printed images according to electrostatic printing techniques wherein during at least a portion of the time when there is produced a latent electrostatic charge image there is undertaken a change in the spacing between an electrode arrangement decisive for the the structure of the charge image and a carrier for the reception of the latent electrostatic charge image and/or a counterelectrode. The invention is also concerned with labels produced according to the method aspects of this development and the use of such labels for marking articles, especially sales articles.

28 Claims, 8 Drawing Figures



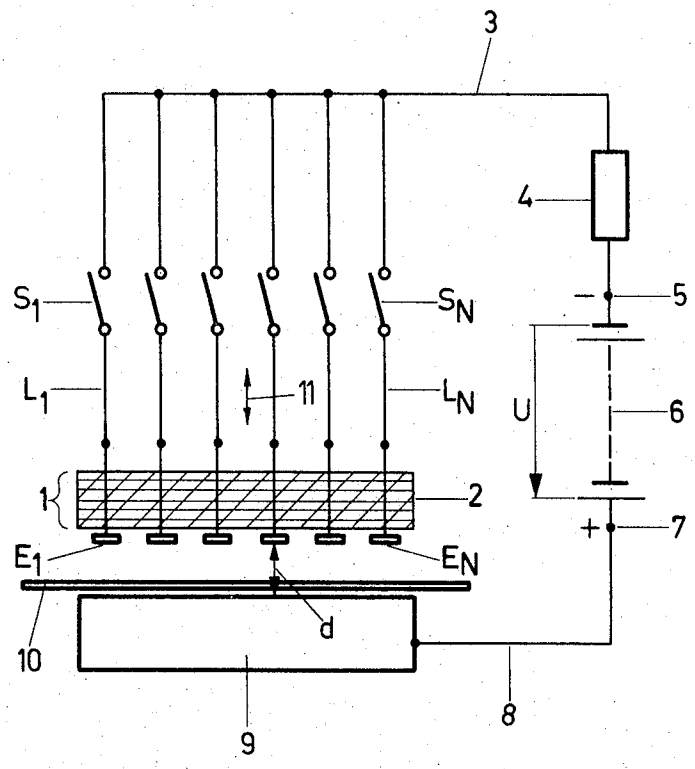
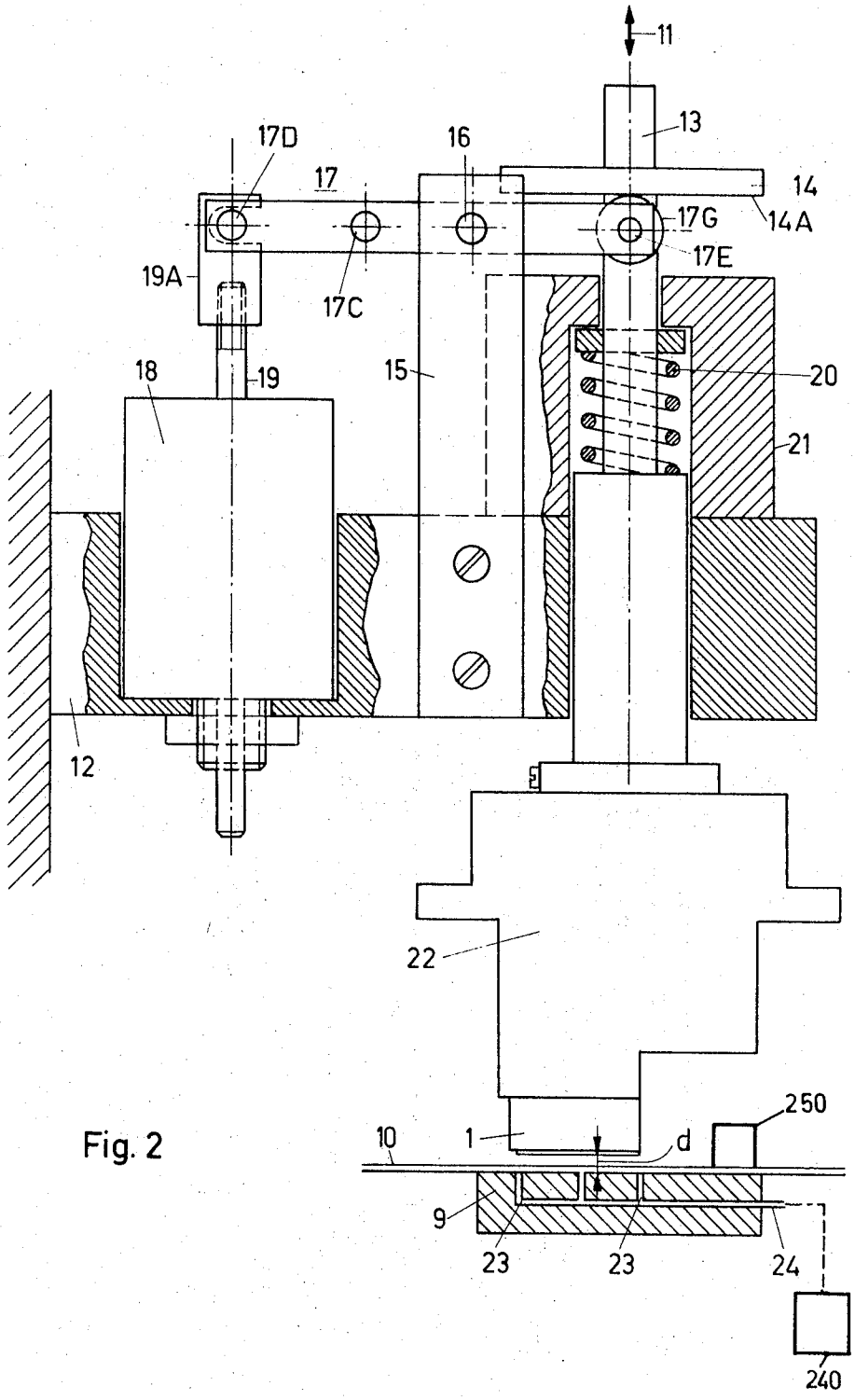


Fig.1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17D
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14A
17G
17E
19A
17C
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15
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10
1
d
9
23
23
24
240

Fig. 2

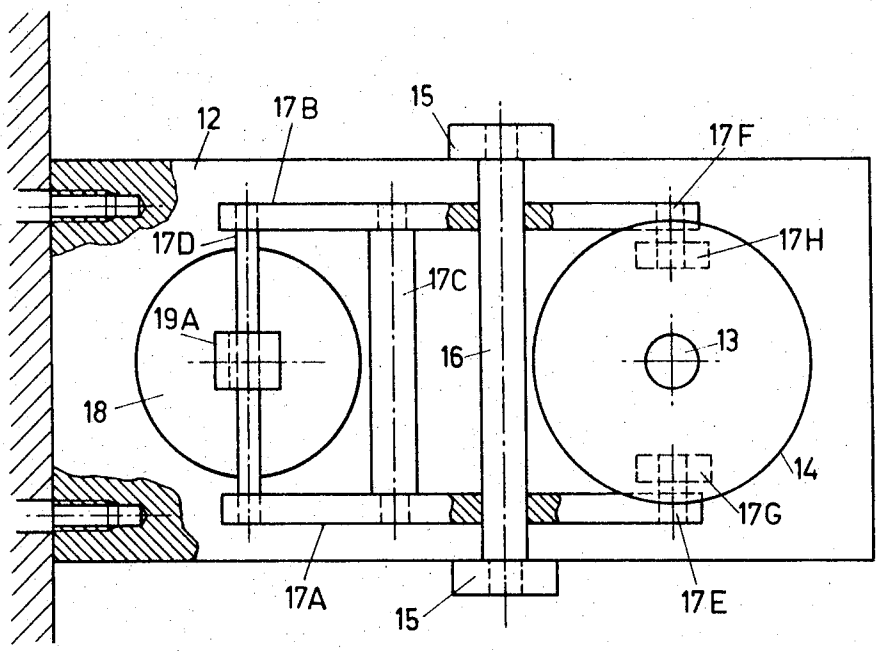
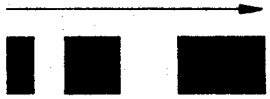
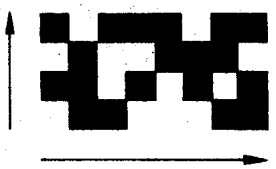


Fig. 3



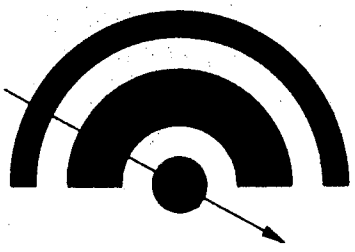
1 0 1 1 0 0 1 1 1

Fig. 4



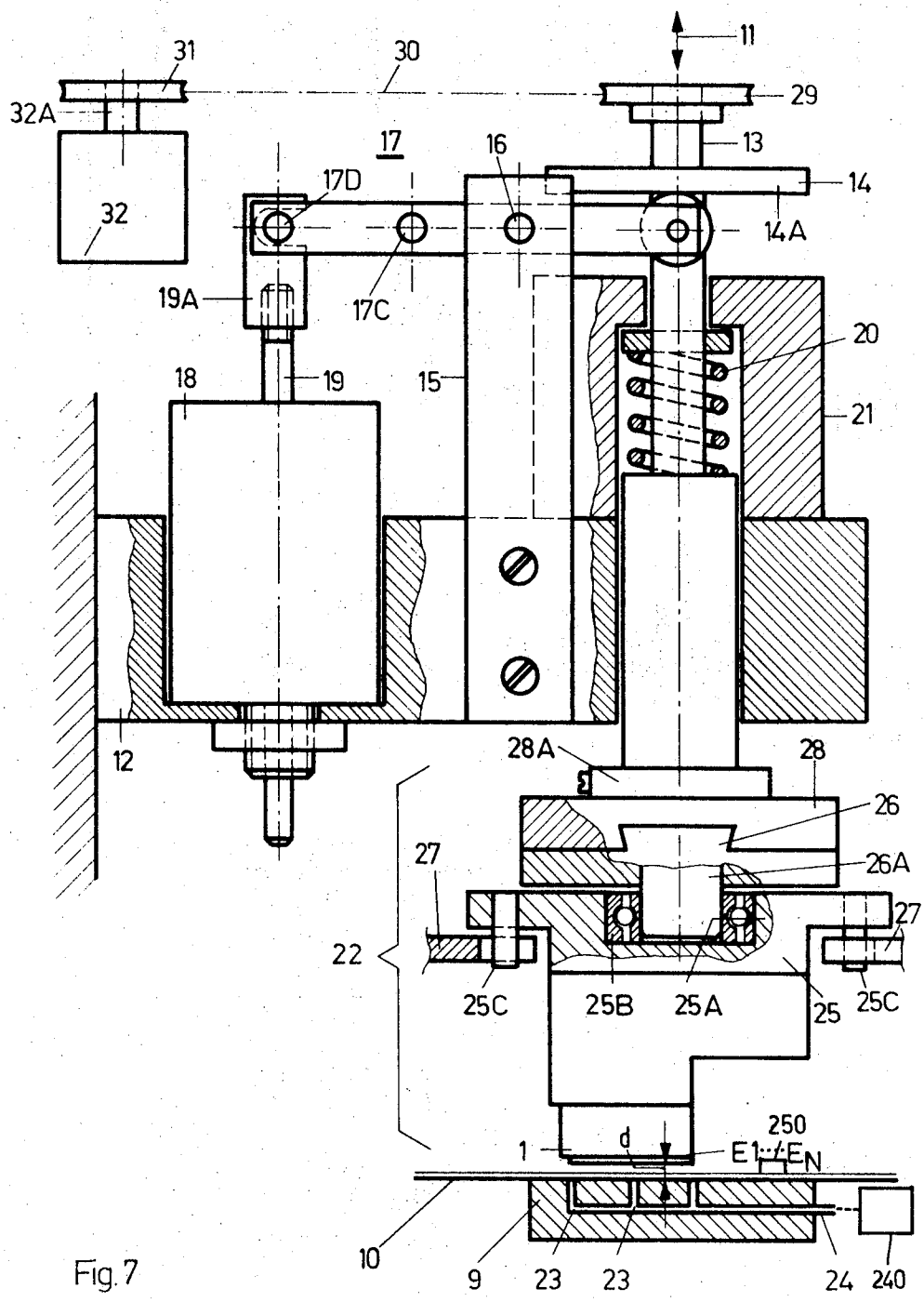
1 0 1 1 1 0 1 1
0 1 0 0 1 1 1 0
1 1 0 1 0 1 0 1
0 1 1 0 0 0 1 1

Fig. 5



1 0 1 1 0 1

Fig. 6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28A
28
26
27
26A
27
22
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E1
EN
10
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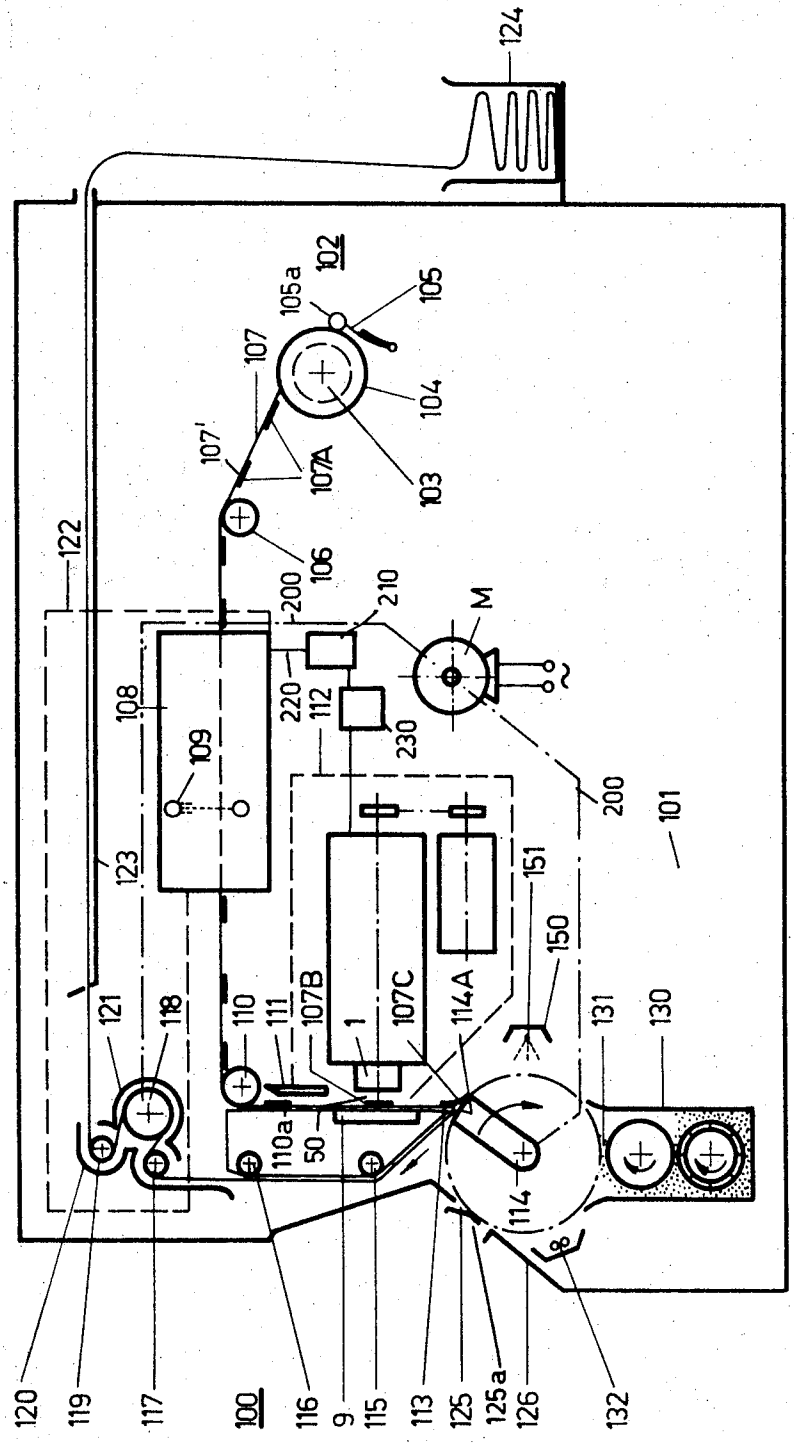
23
23
24
240

Fig. 7


124
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123
151
150
121
118
110
111
107B
1
107C
114A
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110a
50
114
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119
117
100
116
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115
113
125
125a
126
132

Fig.8

METHOD FOR ELECTROSTATIC PRINTING, PRODUCTS PRODUCED THEREBY, AND USE OF THESE PRODUCTS

BACKGROUND OF THE INVENTION

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

The invention is particularly concerned with a method 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 is subsequently developed according to known techniques. These procedures are known and there have also been described in prior art publications equipment for the performance thereof. Although such known techniques are extremely outstanding as concerns both the speed of their capability of producing printed images and their speed as concerns the possibilities of varying the printed images produced thereby, as same are applied in a number of different fields, such as for instance the conversion of digital computer output signals into clear text, still they are not suitable for the production of printed images of high quality. In particular, they are not suitable for producing printed images wherein the line traces or surface elements thereof do not possess any faulty interruptions, gaps or "holes." These defects of the printed image, which hereinafter are conveniently designated as printing errors, are extremely disturbing, for example, in the case of code images as such are employed for instance for making articles of sale. Such code images which can possess, for instance, a beam code, a checkerboard-like pattern, a ring structure or the like, are read-out for evaluation purposes by means of photoelectric readers. The thus resulting electrical pulse sequence or pulse train then corresponds to the sequence of the bright and dark locations of the scanned code image. Since the light spot employed for photoelectric scanning and for realizing high definition or resolution can possess very small dimensions, for instance fractions of a millimeter, the aforementioned printing errors at the code image can result in an erroneous pulse sequence. In order to prevent such type caused defective pulses or faulty pulse gaps at the pulse sequence of the photoelectric reader the line traces or surface elements at the code image to be read-out must be free of such defects or faults.

SUMMARY OF THE INVENTION

Hence, it is a primary object of the present invention to provide a new and improved method of electrostatic printing which is not associated with the aforementioned drawbacks of the prior art and enables considerably increasing the quality of the printed image in contrast to the known proposals in the art.

Still a further significant object of the present invention relates to a new and improved method of electrostatic printing enabling 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 in error free manner.

Yet, a futher significant object of the present invention relates to improved electrostatic printed products, typically labels, produced in accordance with the inventive method.

Another significant object of the present invention relates to the use of the thus produced product, typically labels, for the marking of 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 method for the production of printed images according to electrostatic printing techniques is manifested by the features that during at least a portion of the time when there is produced a latent electrostatic charge image there is carried out a change in the spacing between an electrode arrangement responsible for the structure of the charge image and the carrier for the reception of the latent charge image and/or a counterelectrode.

Not only is the invention concerned with the aforementioned method aspects but also deals with apparatus for the performance of such method which incorporates guide means rendering it possible to carry out a change in the spacing between the electrode arrangement provided for generating the latent electrostatic charge image and the carrier provided for the reception of the latent charge image or the counterelectrode.

As also previously indicated the invention is related to a marker, typically label resulting as a product from the practise of the method, and further the use of the thus produced label product for marking articles, especially articles of sale, as such are found in sundry business establishments.

The terms "carrier" or "label" as used in the context of this disclosure, is not to be considered in a limiting sense, and in fact is intended to conveniently denote any type of printable matter suitable for the purposes 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 details of the mechanical structure of essential components of an embodiment of the invention in elevational view;

FIG. **3** is a plan view of the arrangement of FIG. **2**;

FIG. **4** illustrates a code image in the form of a beam code;

FIG. **5** illustrates a code image in the form of a checkerboard-like pattern;

FIG. **6** illustrates a code image in the form of a ring structure;

FIG. **7** illustrates a further advantageous constructional form of the invention; and

FIG. **8** is a schematic illustration of an 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 accompanying drawings there will be initially explained more fully the basic principles of the invention.

In the practise 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, and this electrostatic charge image is subsequently developed in known manner, for instance in dry fashion by means of a so-called magnetic brush for the application of a toner. What is considered to be particularly novel as concerns this invention is the manner in which the latent electrostatic charge image is produced. This charge image results as a consequence of a discharge phenomena which occurs between a pair of electrodes, namely an electrode arrangement and a counterelectrode at a carrier e.g. label having a relatively high-ohm layer and arranged in the space or region between the aforementioned electrode arrangement and the counterelectrode. A good discussion of the technique of producing printed images or pictorial representations in this manner accordin to electrostatic printing techniques can be found in, for instance, Taschenbuch der Nachrichtenverarbeitung, Karl Steinbuch, Second Edition 1967, Springer publishers Berlin/Heidelburg/New York, Library of Congress Catalogue Card Number 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 in order that there can be produced at the neighboring carrier a latent electrostatic charge image possessing a predetermined structure corresponding to the electrode arrangement and its voltage impingement. Such type charge images produced in this known manner apparently do not possess any sufficiently homogeneous potential distribution within the line traces or surface elements associated with the thus produced printed image. Such inhomogeneous potential distribution within the relatively fine line traces or small surface elements of the image can be hardly experimentally determined owing to the thereat located infinitesimally small quantities of charge. Since, however, even with extensive variations in the developing techniques and the parameters of the developing operations there was always again noticed the aforementioned printing errors at printed images produced according to the heretofore known techniques, it appears that the aforementioned assumption is relevant.

Through extensive experiments and trails it has now been found that by changing the discharge operations which occur during formation of the latent electrostatic charge image, that is, by bringing about a change in the spacing between the electrode arrangement and the carrier for the electrostatic charge image, which change in spacing is undertaken during the discharge operations occurring during the formation of the charge image, it is possible to produce electrostatic charge images which, after development, form printed images of considerably improved quality. It can therefore be assumed that owing to this change in spacing the partial discharges required for the formation of the charge image always travel through new paths, and thus there is realized a notable uniform potential distribution at the line traces or surface elements of the charge image.

The aforementioned change in spacing produces the noted good results both when such constitutes a reduction as well as an increase in the spacing between the carrier and the electrode arrangement. Thus, it has been found to be reliable if such change in spacing is undertaken up to a point of actual contact of the electrode arrangement and the carrier, without however such contact actually being necessary to realize the aforementioned improvement.

The aforementioned change in spacing can be undertaken either by moving the electrode arrangement itself or also by carrying out movement of the carrier for itself, or by simultaneously performing both techniques. The carrier is preferably located at the counterelectrode. With suitable movement of the counterelectrode it is then possible to alter the spacing between the electrode arrangement and the carrier disposed upon the counterelectrode. The electrode arrangement and its individual electrodes which have voltage supplied thereto for producing a charge image of prescribed configuration, are connected with one pole of the voltage source via an external current circuit containing the selector control for the charge image to be produced. The counterelectrode is connected with the other pole of the voltage source. Depending upon the desired polarity of the charge image to be produced which, in turn, is dependent upon the polarity of the developer which later is to be employed, 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 the voltage preferably amounts to about 450 to 1,000 volts.

Now, it is advantageous for current limiting purposes following initiation of a discharge operation to design the external current circuit to the electrode so as to be relatively high-ohmic. A resistance value in the order of magnitude of about 100 kiloohms has provided good results. Those individual electrodes of the electrode arrangement from which no discharge operation occurs to the carrier and through such to the counterelectrode, for the purpose of producing a certain charge image of a predetermined configuration, are advantageously galvanically connected with a point of considerably lower potential than the remaining individual electrodes furnished with voltage. Preferably they are galvanically connected with the counterelectrode. This galvanic connection can be thus advantageously selected to be very highohmic, for instance resistance values in the order of magnitude of approximately 10 megaohms to 100 megaohms have provided good results.

The control of the selector control for the selective connection of each of the individual electrodes of the electrode arrangement with the voltage source can be undertaken both manually, for instance by actuating key or push button switches as well as with the aid of electronic switching circuit arrangements.

Thus, it is possible for instance to introduce a pulse sequence characterizing certain information which is to be represented in the form of a printed image, into a shift register having a suitable number of counting stages. Following the complete input of the pulse sequence into the shift register there then appear at transverse outputs of the individual stages of such shift regis-

ter 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 manner there can be produced a charge image which corresponds to the aforementioned pulse sequence and the information to be expressed thereby. After developing the charge image there is obtained in the aforementioned manner a code image characterizing such information. This has been discussed more fully in, and circuitry suitable for this purpose has been disclosed in, our commonly assigned, copending United States application, Ser. No. 272,111, filed July 17, 1972, entitled "Method For Making Articles Of Sale And Apparatus For The Performance Of The Aforesaid Method," to which reference may be readily had.

With the foregoing background in mind, and turning attention now initially to the arrangement of FIG. **1** there is shown therein an electrical circuit diagram of a first exemplary embodiment. More specifically, it will be understood that an electrode arrangement **1** possesses N-number of individual electrodes $E_1 \ldots E_N$ attached in an individually 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 $S_1 \ldots S_N$ is connected to a conductor **3** which leads via a resistor **4** to a pole **5,** for instance the minus 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 example the positive pole, of this 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 the reception of the latent electrostatic charge image. The carrier **10** is advantageously snugly disposed upon the counterelectrode **9.** The electrode arrangement **1** is mounted in a suitable guide arrangement which has not been particularly illustrated in FIG. **1,** but will be considered more fully hereinafter, in such a manner that it can be displaced in the direction of the double-headed arrow **11.** Thus, the spacing *d* between the electrode arrangement **1** and the counterelectrode **9** and the surface of the carrier **10** can be readily changed. Mechanism suitable for carrying out this spacing change and its mechanical structure will be explained more fully hereinafter in conjunction with FIGS. **2** and **3.**

The switches $S_1 \ldots S_N$ can be activated manually by push buttons or keys or, as already mentioned, there can be provided for instance for this purpose 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 the possibly provided control circuit form a selector 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.

The specific technique of furnishing individual ones of the electrodes with power and details of possible circuits suitable for such purpose constitutes subject matter of our aforementioned copending application, and therefore, will not be further considered herein since same is not thought to be necessary for understanding the subject matter of this development. These principles have been merely considered herein to the extent necessary to provide background towards the understanding of the inventive method and equipment.

Hence, turning attention now to FIG. **2** there is disclosed therein a possible constructional form of the essential components of an exemplary embodiment of the inventive apparatus as depicted in elevational view. FIG. **3** shows the same arrangement in plan view. In all Figures the corresponding components have been designated with the same reference characters.

A shaft **13** is axially displaceably mounted at a support or carrier **12** secured to the housing or frame of the equipment. Shaft **13** can be displaced in the direction of the double-headed arrow **11.** To this end, the shaft **13** possesses a flange **14** with a contact surface **14A.** At both sides of the support **12** there are secured two brackets or supports **15,** as best seen by referring to FIG. **3.** Between both brackets **15** there is mounted a shaft or axle **16.** At this shaft **16** there is pivotably mounted a pivotal frame **17** possessing both of the pivot arms **17A** and **17B,** a first connection element **17C** and a second connection element **17D.** Each of the pivot arms **17A** and **17B** carries at its right-hand end, in the illustration of FIGS. **2** and **3,** a journal or axle portion **17E** and **17F** respectively, pressed or force fitted into the just-mentioned respective end of the associated pivot arm and at which there is rotatably arranged a respective contact roller **17G** and **17H.**

Furthermore, at the support **12** there is mounted an electromagnetic system **18** in such a manner that a traction or pull rod **19** comes to rest beneath the connection piece **17D.** A coupling piece or element **19A** of the traction or pull rod **19** is adjustably attached thereto. The coupling piece **19A** at least partially engages about the second connection piece **17D** of the pivotal frame unit or frame **17.** Upon excitation of the electromagnectic system **18** its traction or pull rod **19** is retracted downwardly, so that the pivotal frame **17** lowers at the left side of the axle **16** and at the right side thereof is raised. Owing to this movement the rollers **17G** and **17H** press against the contact surface **14A** of the flange **14.** As a result, the shaft **13** is displaced upwards. By means of a spring **20** arranged in guide housing **21** this shaft **13** is again lowered after switching-off or deenergizing the electromagnetic system **18.** Due to the action of the electromagnetic system **18** and the spring **20** it is thus possible to displace the shaft **13** in the direction of the double-headed arrow **11** i.e. towards and away from the carrier **10** and counterelectrode **9.**

Now upon the shaft **13** there is secured a holder mechanism **22** for the electrode arrangement **1** (FIG. **1**). 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 is drawn or pulled, by means of a suitable feed mechanism, such as unit **122** to be considered hereinafter in conjunction with FIG. **8,** the carrier **10** for the latent charge image which is to be imprinted. The carrier **10,** in its broadest sense the label, during the production of the charge image is advantageously fixedly retained in its momentary position, for instance under vacuum action by means of channels or bores **23** at the counterelectrode **9** connected via a conduit **24** with a suitable controllable vacuum device **240** or other source of negative pressure. Also an electromagnet-

ically actuated holddown or clamping mechanism **250** for the carrier **10** can be employed. In the embodiment under consideration the counterelectrode **9** is preferably rigidly secured in the entire frame of the apparatus.

During the production of special printed images, for instance code images according to the described method aspects of this development, certain difficulties arise. Now according to a further advantageous physical manifestation of the invention these difficulties can be effectively overcome. In order to fully comprehend the same there will now be considered the special problem which particularly arises during the printing of such code or coded characters, hereinafter simply referred to as code images or characters. Turning therefore attention now to FIGS. **4, 5** and **6** there are illustrated thereat different types of arrangements of code images, such as can be used for instance for characterizing or marking goods or articles for sale. In FIG. **4** there is show a beam-type code, in FIG. **5** a checkerboard-type code image and in FIG. **6** a code image having a ring structure, for instance formed of a series of concentric rings. Of course other configurations of code images can be obviously employed without departing in any way from the spirit and scope 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 a beam, square or ring can for instance signify the binary value 1 and a white surface element of similar geometric configuration can then signify the binary value 0. Both black and white surface elements can directly follow one another. Now for the automatic electro-optical reading of such code images there is scanned in known manner across the relevant code image under consideration and parallel thereto or in the direction of the indicated arrows a beam of light and the periodically reflected light is converted by a photoelectric transducer into a sequence of electrical pulses and delivered to a known evaluation device. The technique of reading-out the code characters or code markings constitutes subject matter of other applications assigned to the assignee of this application and is not necessary for the understanding of the concepts of this development, and therefore will not be considered in any greater detail herein.

However, it is here mentioned for the purpose of avoiding false or erroneous reading results it is necessary that between directly following black surface elements, in other words between for instance directly following black surface elements each of which represent a binary value **1** that there do 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 there 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 elements respectively, considering the normally small spacing 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 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 formation of the charge image only those individual electrodes associated with 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. **4.** In the event it is desired to form a code image of the type depicted in FIG. **5** 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. **6**, 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, as previously mentioned, a uniform blackening of the black surface elements provides an improvement in the read-out integrity of the code image.

Now with the foregoing in mind and in conjunction with FIG. **7** there will be discussed a further advantageous constructional embodiment of the invention for realizing these objectives. The basic construction extensively corresponds to the construction according to the arrangement of FIGS. **2** and **3**, but on the other hand the holder mechanism **22** for the electrode arrangement **1** is here modified. Additionally, there are also present in this embodiment certain further components.

Now the constructional embodiment of apparatus depicted in FIG. **7** serves for producing code images of the type depicted in FIG. **6**. The individual electrodes $E_1 \ldots E_N$ of the electrode arrangement **1** possess a substantially semi-circular ring-shaped configuration. They can, for instance, be arranged according to the technology of printed circuits, for instance upon an epoxy glass fiber plate. In order to increase wear resistance they can be galvanically finished, for instance covered with a hard gold or rhodium coating.

The width of the individual ring-shaped electrodes is chosen in consideration of the insulation required therebetween and can amount to, for instance, only 0.2 millimeters, whereas the spacing to the neighboring individual electrode can amount to for instance 0.8 millimeters. For increasing the width or size of a surface element of the charge image and the code image to be developed, the electrode arrangement **1** can have imparted thereto through the agency of an eccentric mechanism a circular-shaped displacement movement in a plane which is perpendicular to the shaft **13**, defining the aforementioned relative movement between the electrode arrangement and the carrier.

To this end the electrode arrangement **1** is secured to a guide element **25**. This guide element **25** possesses a central bore **25A** in which there is inserted a ball bearing **25B**. In this ball bearing **25B** there engages an eccentric pin **26A**. The guide element **25** is secured against rotation in that two guide bolts **25C** force fitted therewith engage with a respective bifurcated or fork-shaped stationary guide piece **27**. The eccentric pin **26A** is part of an eccentric plate **26** which is adjustably secured in a counterpiece **28** in the transverse direction with regard to the shaft **13**. This counterpiece **28** possesses a hub **28A** which is secured to the lower end of the shaft **13**.

At the upper end of the shaft **13** there is secured a belt pulley or pulley disk **29**. A schematically represented belt **30** connects the belt pulley **29** with a further belt pulley **31** which is seated upon the shaft **32A** of a drive motor **32**. By means of this drive motor **32** the shaft **13** can be placed into rotation through the agency of the belt **30**. Depending upon the selected lateral or transverse displacement of the eccentric plate **26** at the counterpiece **28** the eccentric pin **26A** carries out smaller or larger eccentric circular movements which are transmitted via the guide piece **25** to the electrode arrangement **1**. In this way there is realized the desired transverse or lateral relative movement between the electrode arrangement **1** and the carrier for the labels as previously discussed.

Now in FIG. **8** there has been schematically depicted the general overall arrangement of an electrostatic printing apparatus suitable for the practise 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 **105***a* 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 practise 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 Paper," 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** for continuous or intermittent feed. 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 or any other suitable information for the data pattern or the like which later is to be electrostatically imprinted. Moreover, special markings of such preprinted 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. **2, 3** and **7.** 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 rotating arm, a roller or equivalent device, and which receives at its end face or 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 ensure 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" 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 electri-

cally 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 ensures that there will occur a repulsion of the charge toner particles from the locations of the label which should remain white. Owing to these measures the contrast of the electrostatically 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 of 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 practised within the scope of the following claims.

Accordingly, what is claimed is:

1. A method of producing printed images by electrostatic printing techniques, comprising the steps of producing a latent electrostatic charge image on a carrier, and during at least a portion of the time when the latent electrostatic charge image is produced carrying out a change in the spacing between an electrode arrangement which is responsible for the structure of the electrostatic charge image and the carrier for the reception of the latent electrostatic charge image, said change in spacing causing partial discharges for the formation of the electrostatic charge image to travel through different paths across the space between the electrode arrangement and the carrier to provide a substantially uniform potential distribution within the confines of the electrostatic charge image to be produced, so as to bring about a substantially uniform covering of toner particles over the surface of the electrostatic charge image to thereby improve the quality of the electrostatically printed image, contacting the electrostatic charge image with toner particles, and fixing the toner particles to the carrier.

2. The method as defined in claim **1**, wherein the change in the spacing is undertaken by approaching or removing the electrode arrangement towards or away from the carrier.

3. The method as defined in claim **1**, wherein the change in the spacing is carried out by approaching or removing the carrier towards or away from the electrode arrangement.

4. The method as defined in claim **1**, wherein the change in spacing comprises moving both the electrode arrangement and the carrier.

5. The method as defined in claim **1**, wherein said change in spacing comprises creating relative movement between the electrode arrangement and the carrier in alternate directions and having movement components substantially parallel to the plane of the carrier.

6. The method as defined in claim **5**, including the step of maintaining the carrier stationary, and shifting the electrode arrangement in a direction substantially perpendicular to the plane of the carrier to carry out said change in spacing and also in a lateral direction transverse to the direction of such change in spacing between the electrode arrangement and the carrier.

7. The method as defined in claim **1**, including the step of maintaining the electrode arrangement stationary, and shifting the carrier towards or away from the electrode arrangement and moving the carrier in a direction transverse to the direction of change in the

spacing between the electrode arrangement and the carrier.

8. The method as defined in claim **1**, further comprising placing both the electrode arrangement and the carrier in motion in the direction of change in the spacing between the electrode arrangement and the carrier and in a direction substantially transverse thereto.

9. The method as defined in claim **1**, further including the steps of carrying out relative movement essentially at the same time between the electrode arrangement and the carrier, controlling the spacing between the electrode arrangement and the carrier and in a direction substantially transverse thereto.

10. The method as defined in claim **1**, further including the steps of carrying out relative movement at different periods of time between the electrode arrangement and the carrier in a direction which changes the spacing therebetween and in a direction substantially transverse to the direction of changing the spacing between the electrode arrangement and the carrier.

11. The method as defined in claim **1**, further including the step of delivering voltages required to the electrode arrangement and a counterelectrode.

12. The method as defined in claim **5**, further including the step of delivering voltages required to the electrode arrangement and a counterelectrode in a direction transverse to the direction of altering the spacing between such electrode arrangement and the carrier.

13. The method as defined in claim **1**, further including the steps of providing an electrostatic printing mechanism, and delivering thhe carrier in a stepwise fashion to the electrostatic printing mechanism for producing the latent electrostatic charge image.

14. The method as defined in claim **1**, including the step of providing an electrostatic printing mechanism, and delivering the carrier with the printed image continuously to the electrostatic printing mechanism for producing the latent electrostatic charge image.

15. The method as defined in claim **1**, further including the step of providing a corona discharge device, and delivering the carrier to the corona discharge device.

16. The method as defined in claim **1**, further including the step of providing a developer, and respectively delivering the carrier provided with a latent electrostatic charge image towards and away from the developer.

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

18. The method as defined in claim **5**, further including the step of controlling the amplitude of the relative movement transverse to the direction of change in the spacing between the electrode arrangement and the carrier so as to be at least so large that surface elements of the latent electrostatic charge image and the developed printed image at least abut one another without any intermediate gaps.

19. The method as defined in claim **5**, further including the step of controlling the amplitude of the relative movement transverse to the direction of change in the spacing between the electrode arrangement and the carrier so as to be at least so large that surface elements of the latent electrostatic charge image and the developed printed image slightly overlap one another.

20. The method as defined in claim **5**, further including the step of providing a counterelectrode, applying voltage by means of a manual control device serving for the initiation and periodic maintenance of an electrical discharge between the electrode arrangement and the counterelectrode for producing a latent electrostatic charge image which corresponds to the desired printed image.

21. The method as defined in claim **1**, further including the step of providing a counterelectrode and an automatic control circuit for the selection of individual electrodes of the electrode arrangement for the production of the latent electrostatic charge image corresponding to a desired printed image and which electrodes are to have applied thereto voltage for the initiation and periodic maintenance of an electrical discharge between the electrode arrangement and the counterelectrode.

22. The method as defined in claim **21**, further including the steps of providing a weighing device having an output signal, and applying the voltage to the individual electrodes of the electrode arrangement automatically as a function of the output signal of the weighing device.

23. The method as defined in claim **1**, further including the steps of providing an electrostatic printing mechanism and a feed mechanism, storing at a supply device the carriers for the latent electrostatic charge image upon a carrier foil strip and delivering such by means of the feed mechanism to the electrostatic printing mechanism.

24. The method as defined in claim **23**, including the step of placing said feed mechanism into operation for successively advancing the carrier foil strip with the thereon adhering carriers for the charge image.

25. The method as defined in claim **24**, including the step of deflecting the carrier foil strip about a sharp edge such that owing to the greater stiffness of the carrier relative to the carrier foil strip the carrier containing the electrostatic charge image is detached from the carrier foil strip, and thereafter delivering such detached carrier to a developer for developing the electrostatic charge image.

26. The method as defined in claim **25**, including the step of delivering the carrier foil strip freed of carriers to a predetermined location for subsequent reuse.

27. The method as defined in claim **1**, including the step of employing the thus produced carrier as a label for the marking of articles.

28. A method of producing printed images by electrostatic printing, comprising the steps of producing a latent electrostatic charge image on a carrier, and during at least a portion of the time when the latent electrostatic charge image is produced carrying out a change in spacing between an electrode arrangement responsible for the structure of the electrostatic charge image and a counterelectrode, said change in spacing causing partial discharges for the formation of the electrostatic charge image to travel through different paths across the space between the electrode arrangement and the carrier to provide a substantially uniform deposit of charges and therefore a substantially uniform potential distribution within the confines of the electrostatic charge image to be produced, so as to induce a substantially uniform covering of toner particles over the surface of the electrostatic charge image to thereby improve the quality of the electrostatically printed image, contacting the electrostatic charge image with toner particles, and fixing the toner particles to the carrier.

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