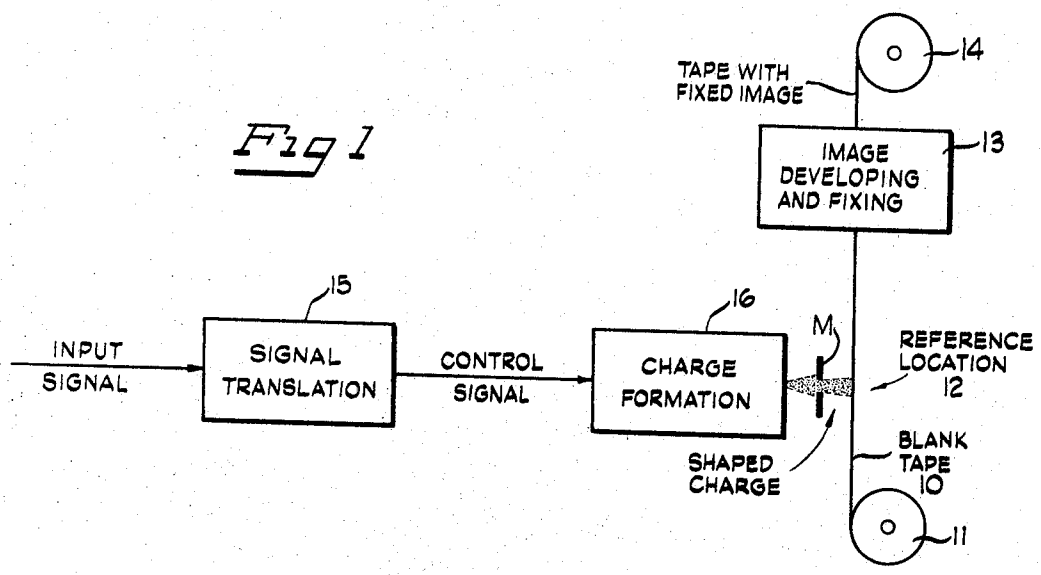
Aug. 8, 1967 H. EPSTEIN ETAL 3,335,322

CHARGE HEAD ARRAY FOR ELECTROSTATIC PRINTING SYSTEM

Filed May 6, 1966

Fig 1



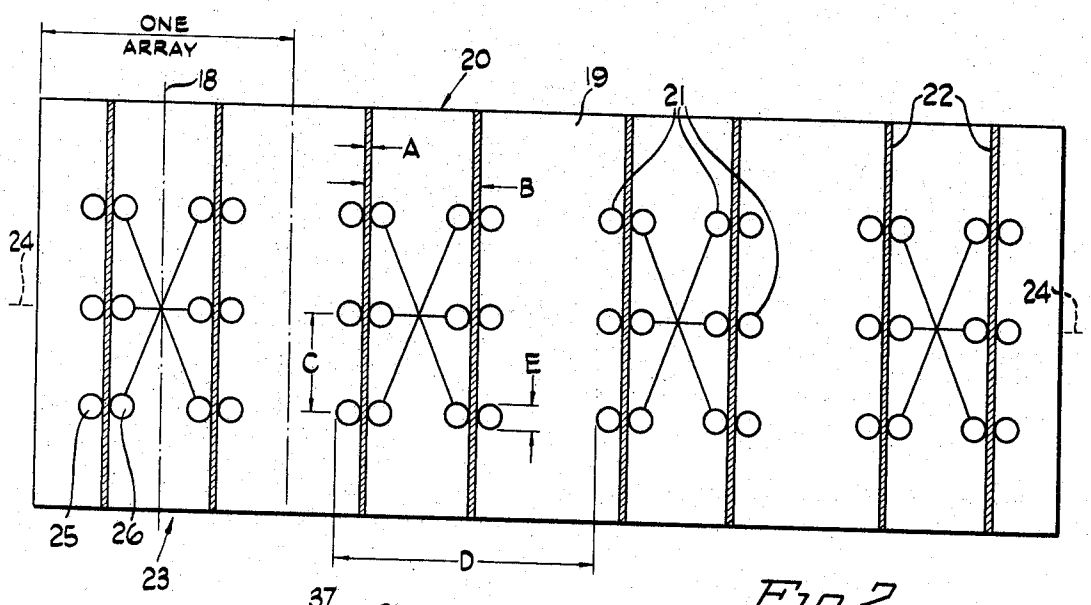




Fig 2

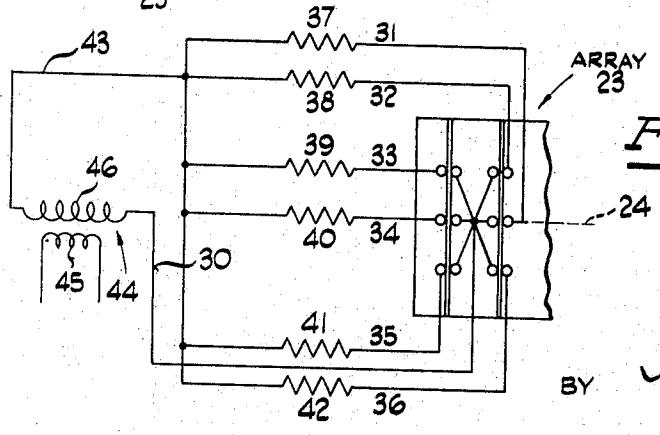



Fig 3

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# CHARGE HEAD ARRAY FOR ELECTROSTATIC PRINTING SYSTEM

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The present invention is directed to a charge head for an electrostatic printing system in which charged areas of different configurations are deposited on a tape, and more particularly to a novel and unobvious structure and circuit arrangement for providing a mass or cloud of charge particles suitable for use in such a system.

This appplication is a continuation-in-part of an earlier application, now abandoned, entitled, Information Transfer System, filed Apr. 9, 1964, Ser. No. 358,429, which is assigned to the assignee of this invention.

With the advent of electrostatic printing equipment, increasing attention has been directed to the production of a shaped mass of particles for deposition directly on a tape or web. By an electrostatic printing system is meant one in which a tape is first selectively charged by the adherence of charge particles to discrete areas on the tape. The latent image thus produced is then "developed" as minute conductive particles adhere to the charged tape areas, to provide at least a temporary indication of the information implanted by the selective charging. Thereafter the developed image is fixed in place to provide a permanent, visible record of the information initially imparted by the charging of selective areas on the tape.

In the initial or tape-charging step, it is desirable to provide a large mass or cloud of particles, that is, larger than a stencil aperture denoting a specific symbol to be represented on the tape. To insure the production of the requisite amount of charge particles, it is desirable to provide a compact and highly efficient charge head to produce the mass of charged particles for subsequent direction through the stencil aperture onto the tape or paper. It is toward the production of such a novel charge head that the present invention is directed.

In one embodiment the present invention includes a charge head having a plurality of arrays, each of which includes a plurality of pairs of electrodes. With respect to the central axis of each array, one electrode of each pair is closer to such axis than is the other electrode in the pair. All of the electrodes closer to the axis are electrically coupled to a first common line. The remaining electrodes, that is, the electrode in each pair farther from the central axis, are individually coupled to a second common line. With this charge head configuration, upon the application of a discharge signal to the common lines, the amount of charge particles created for direction through the stencil aperture onto the tape is adequate to produce a well-defined charged area on the tape.

In order to acquaint those skilled in the art with the best mode contemplated for making and using the invention, a detailed description thereof is set forth in connection with the accompanying drawing, in the several figures of which like reference numerals identify like elements, and in which:



FIGURE 1 is an illustrative showing, partly in block form, of a system in which the present invention finds utility;

FIGURE 2 is a bottom view of the working face or that portion of a discharge head closest to the moving paper web; and

FIGURE 3 is an illustrative showing, partly in schematic form, of the electrical intercoupling for applying the discharge potential across the individual pin electrodes of a discharge head to produce the desired mass of charged particles.

*System arrangement*

As illustrated in FIGURE 1, a blank tape **10** is provided for gradual removal from a supply reel **11**, for passage adjacent a reference location **12**. A cloud of charge particles is shaped by passage through an aperture in mask M and the shaped charge is directed onto the tape. The tape, with one or more information-denoting charged areas thereon, is then passed through an image developing and fixing stage **13** and wound on take-up reel **14**, with the fixed image thereon. To regulate the discharge at location **12**, input signals may be received at the input side of a signal translation stage **15**, in which the signals are suitably modified or operated upon to provide one or more control signals for application to a charge formation stage **16**. In stage **16** several signals, denoting timing, physical position, information content, etc., may be combined to provide the requisite discharge toward one or more openings in stencil M to effect the movement of the shaped charge onto the tape. It is toward the provision of a novel and unobvious discharge head for use with such a system that the present invention is directed.

*Charge head*

It is emphasized that the showing of FIGURE 2 is a bottom view, that is, the portion of the charge head which is visible would be seen looking from the web through a mask aperture toward the charge head. Of course, the entire extent of the charge head will not be visible, nor would the complete extent of one array be visible, for the dimension of each aperture is less than the overall dimensions of the charge cloud produced by one array. The main body of the charge head (not visible) may be produced by conventional techniques, using a resin such as Hysol 2038. After this resin is poured, it "sets up" or hardens to form the body portion of discharge head **20**. It is the lower face of head **20** which is shown in FIGURE 2, and the major portion of this lower face is comprised of a glass-filled epoxy **19**, designated G10 and available from Laminated Materials in Philadelphia, Pa. This material provides the resquisite wear and heat resistance characteristics. Ceramic pieces, molded or machined to the desired shape, may be substituted for the epoxy resins. The pin electrodes **21** of each array are comprised of tungsten, and the insulating strips **22** between the electrodes are formed from a mica sheet. Strips **22** can also be of quartz. A technique suitable for the assembly of such a head is described in Patent No. 3,124,804, entitled Electrostatic Recording Head, which issued Mar. 10, 1964, and is assigned to the assignee of this application. As will become apparent, it is the particular location of the electrodes and their selective intercoupling and driving during the charge formation process

that emphasizes the novelty and unobviousness of the instant invention.

Although four different arrays are depicted in FIGURE 2, in that each array is similar in all respects to the others, only array **23** (at the far left of FIGURE 2) will be described in detail. By "array," as used in this explanation and in the appended claims, is meant all of the electrodes which cooperate in producing a single mass or cloud of particles for passage through one stencil aperture onto the tape.

It is evident that array **23**, even as the other arrays, is symmetrical about a central axis or center line **18**, which is perpendicular to the center line **24** of the entire discharge head. In this preferred embodiment, the array comprises twelve tungsten pin electrodes, which may be viewed as a plurality of pairs of electrodes. Each pair of electrodes, for example, the lower left pair including electrodes **25** and **26**, has one specific electrode (**26** in this instance) which is nearer the array axis **18** and an outer electrode (**25**) which is farther from the array center line. There is utility and novelty in utilizing two pairs of pin electrodes, and thus a phrase such as "plurality of pairs of electrodes" in the claims is intended to embrace two or more pairs of electrodes. In the preferred embodiment, six pairs of pin electrodes are employed as illustrated.

To assist those skilled in the art in making and using the invention, the dimensions of salient portions of the head structure shown in FIGURE 2 are given. However, it is again emphasized that such teaching is by way of illustration only and in no sense by way of limitation. The thickness of mica insulating strips **22** represented by A in FIGURE 2, was 0.002 inch, or 2 mils. Likewise, B represents the distance between the two mica strips plus the thickness of both strips, which in this embodiment was 0.035 inch. C denotes the center-to-center distance between adjacent pins in one array and on one side of the mica strip, which distance was 0.033 inch. The array-to-array spacing, designated D, was 0.100 inch. The thickness of a single tungsten pin electrode, represented by letter E, was 0.010 inch in the preferred embodiment. With this explanation and the teachings of the above-identified patent, those skilled in the art will be able to construct the novel and unobvious charge head whether one or more arrays are desired in the actual head.

*Energization of one array*

FIGURE 3 illustrates a preferred energization circuit for the electrodes in a single array. As there shown, a first common conductive means or line **30** is provided and coupled in common to the pin electrode, of each pair of electrodes in the array, which is nearer to the center line of one array in the charge head. The other electrode of each pair, that is, all those electrodes farther from the axis of the array shown, are individually coupled over the respective ones of conductors **31–36** and the dropping resistors **37–42** to another common line **43**. A transformer **44** is provided, with a primary winding **45** for receiving the control potential signal, and a secondary winding **46**, the opposite ends of which are coupled to conductors **30** and **43**. Accordingly, the application of a suitable potential across winding **45** is stepped up across winding **46** to provide the requisite break-down potential between each of the respective pairs of pin electrodes in array **23**. In one embodiment, the breakdown potential applied between conductors **30** and **43** was of the order of 1400 to 2000 volts, measured with respect to an anvil or backing electrode (not shown) which may be disposed on the side of the paper web remote from the discharge head.

It is noted that, in the illustrated embodiment, the common electrodes are those nearer the axis or center line of one array in the head. If there are no resistors in either set of leads, one pair of pins of the six pairs in an array tends to discharge first, and after that the other pairs in the array will not discharge. The individual resistors, one coupled in each discharge path, insure that all pairs of pin electrodes fire. Accordingly, the resistors can be in the lines coupled to the outer pins in the array, as illustrated; alternatively, the outer lines can be tied in common, and the individual resistors can be coupled between conductor **30** and each of the inner electrodes. From the standpoint of construction, it is more convenient to couple the individual resistors to the outer electrodes as shown. In addition, this positioning of the resistors provides a somewhat greater "cloud" of discharge particles, in that the main area of charge particle formulation occurs at the electrode to which the resistor is coupled.

It is noted that each array of the charge head described and claimed herein has a vertical dimension substantially greater than its horizontal dimension. Considering the working area including the six pairs of electrodes in each array, this area likewise has a greater dimension parallel to center line **18** than in a direction normal to this center line. Accordingly the cloud of charge particles produced in response to application of a discharge pulse to primary winding **45** results in a cloud or mass of particles generally rectangular in cross section rather than square. Thus the present invention finds utility with electrostatic printing systems in which the apertures in the mask M are shaped in correspondence with alphanumeric characters, in that many of such characters have a vertical dimension which exceeds their width.

While a particular embodiment of the invention has been described and illustrated, it is apparent that modifications and alterations may be made therein. It is therefore the intention in the appended claims to cover all such modifications and alterations as may fall within the true spirit and scope of the invention.

What is claimed is:

**1.** In a system for providing a mass of charge particles for direction through a stencil onto a web, a charge head comprising:

an array of electrodes having a central axis and comprising a plurality of pairs of electrodes, with at least a first pair of said pairs of electrodes positioned on one side of said central axis and a second pair of said pairs of electrodes positioned on the other side of said central axis,

a first electrode of each pair being nearer said central axis than the second electrode in each pair,

means for electrically coupling all the first electrodes in the array to a first common line, and

means for electrically individually coupling all the second electrodes in the array to a second common line,

whereupon application of a discharge signal between said common lines produces a mass of charge particles.

**2.** A system as claimed in claim **1** and in which an individual current-limiting means is selectively coupled between each of said second electrodes and said second common line.

**3.** A discharge head for providing a mass of charge particles comprising:

a plurality of arrays of electrodes, each array comprising a plurality of pairs of electrodes disposed about its respective center line, with at least a first pair of said pairs of electrodes positioned on one side of said center line and a second pair of said pairs of electrodes positioned on the other side of said center line,

a first electrode of each pair being closer to the center line of the array than the second electrode in each pair,

means for electrically coupling in common to a first input conductor all of said first electrodes, and

means, including a separate resistor for each of said

second electrodes, for separately coupling to a second input conductor all of said second electrodes,

whereupon application of a discharge signal between the input conductors produces a mass of charge particles.

4. A discharge head as claimed in claim 3 including insulating means positioned in each array between the electrodes of each pair to prevent undesired discharge.

5. A discharge head as claimed in claim 3 in which each array includes three electrode pairs on one side of the array center line and three other electrode pairs on the other side of said center line.



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