Jan. 1, 1963 C. R. JOYCE 3,071,685

ELECTROSTATIC RECORDING HEAD

Original Filed Sept. 12, 1956 2 Sheets-Sheet 1

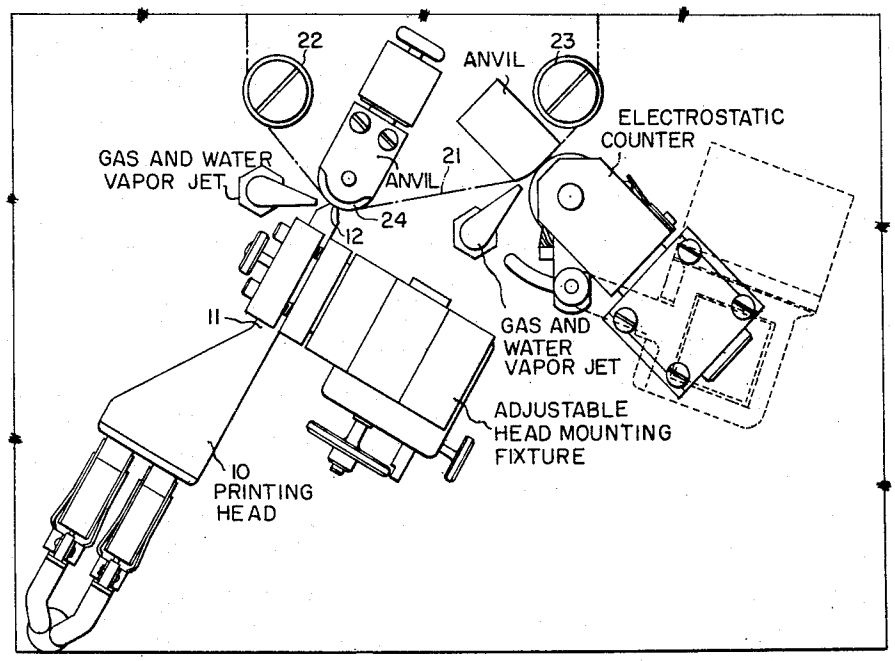


Fig. 1

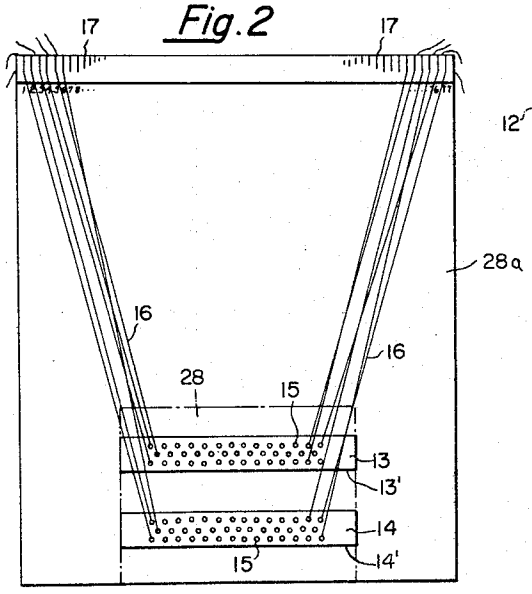


Fig. 2

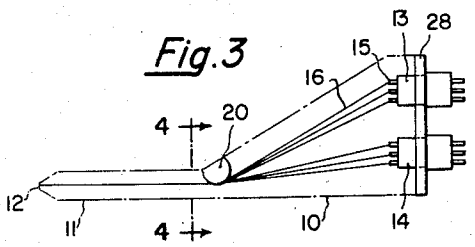


Fig. 3

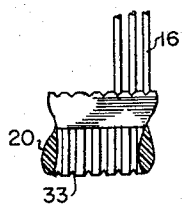


Fig. 4

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ELECTROSTATIC RECORDING HEAD

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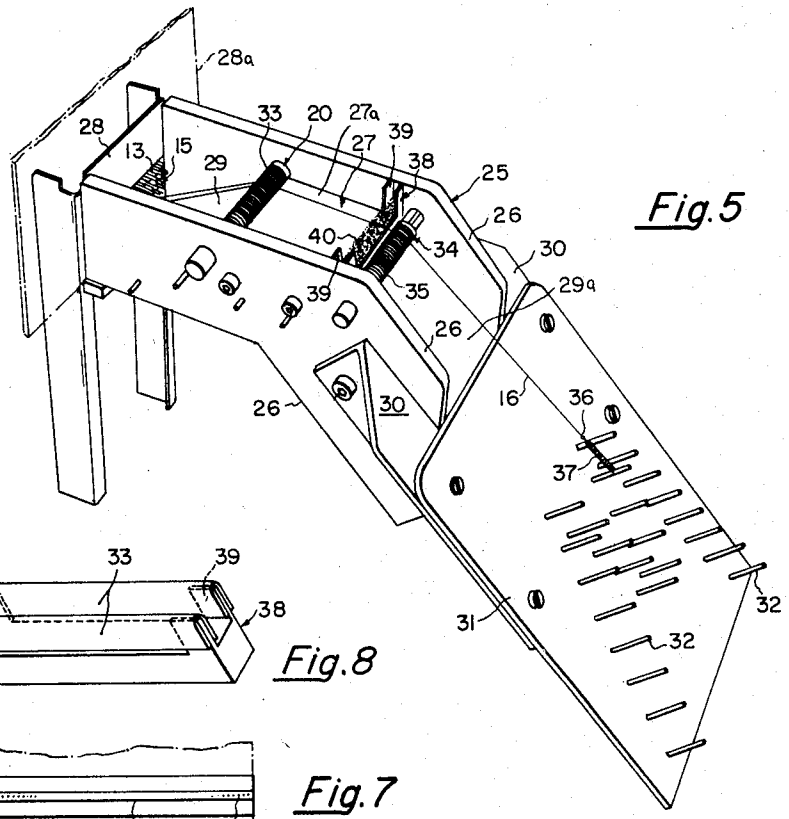


Fig.5

Fig.8

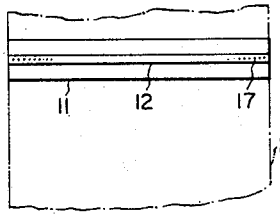


Fig.7

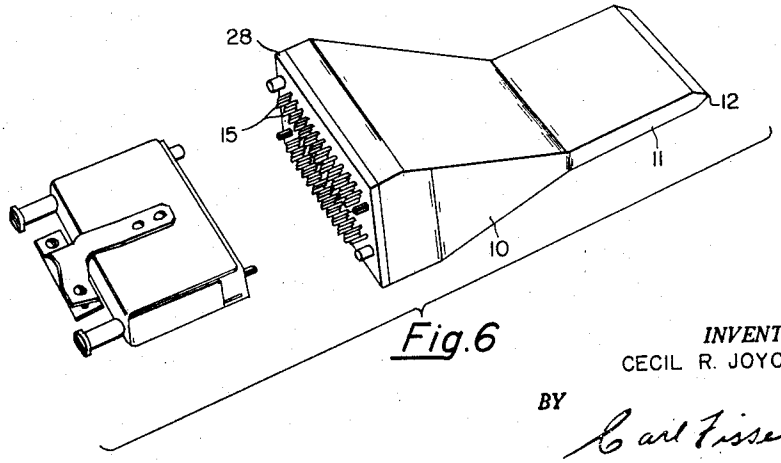


Fig.6

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3,071,685

ELECTROSTATIC RECORDING HEAD

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Original application Sept. 12, 1956, Ser. No. 609,431, now Patent No. 2,974,368, dated Mar. 14, 1961. Divided and this application June 6, 1960, Ser. No. 34,215

7 Claims. (Cl. 250—49.5)

The present invention relates to electrostatic recording and more particularly to a novel head construction having an array of electrodes for printing or plotting data upon a suitable responsive medium. This application is a division of pending application for patent in the name of Cecil R. Joyce, Serial No. 609,431, filed September 12, 1956, entitled "Electrostatic Recording Head and Method for the Fabrication Thereof," now Patent No. 2,974,368 and assigned to the same assignee as the present application.

In the development of electrostatic printing, effective results largely depend upon complicated circuits for character selection requiring a multiplicity of printing electrodes. In the past, and particularly where commercial production is concerned, the problem of properly arranging, separating and mounting such electrodes has introduced a prohibitive cost factor which has seriously retarded efforts to meet trade demands for such equipment.

An object of the present invention is to provide a novel electrostatic recording and printing head wherein the heretofore high cost of such devices has been substantially reduced.

A further object of the present invention is to provide an improved electrostatic printing head in which relatively widely deployed electrode elements are brought together into a compact closely spaced array of printing styli.

In accordance with the objects of the invention and first briefly described, there is provided a novel recording head wherein a plurality of conducting wires are arranged in spaced relation through a molded body of dielectric material with the ends of the wires exposed thus to form a linear array of electrodes, each electrode of which is connected at its other end to a terminal connector. The head is fabricated by first securing the wires under tension, and the terminals in a mold and then layer molding insulating material around the wires and terminals in a manner whereby the molded material is free of bubbles and internal stresses.

In the accompanying drawings:

FIG. 1 is an elevational view of a portion of apparatus employing an electrostatic head embodying one form of the present invention;

FIG. 2 is a plan view of a wire holding element used in manufacturing the present invention;

FIG. 3 is a side view, partially in phantom outline, of the head of FIG. 1;

FIG. 4 is a view on an enlarged scale of a fragmentary portion of the head structure looking in the direction of the arrows on line 4—4 of FIG. 3;

FIG. 5 is a perspective view of one form of mold and wire tensioning mechanism for carrying out the method of the invention;

FIG. 6 is an exploded perspective view of the head and an associated electrical connector;

FIG. 7 is a front view of the recording head of the present invention and showing an associated recording medium in phantom outline; and,

FIG. 8 is an enlarged isometric view of a molding dam used with the present invention.

Referring to the various figures of the drawings, and more particularly to FIGS. 1 and 6 thereof, a printing, plotting or recording head embodying one form of the invention, is shown as comprising a tapered body **10**, and a flat extension **11** having a tapered end portion terminating in a narrow planar face **12** (FIG. 7), all molded of a chemically exothermic material such as epoxy resin. The opposite end panel of body **10** has embedded therein, connector units **13** and **14**, each of which, as seen in FIGS. 1 and 3, includes a plurality of rows of terminals **15** extending therethrough. The inner ends of the terminals are respectively soldered to a plurality of conducting wires **16**, while the outer ends thereof project as plug-in connectors engageable with the wires of a cable pulsing unit or the like, such as seen in FIGS. 1 and 6. Illustratively as seen in FIGS. 2 and 3, each connector unit is provided with three rows of terminals **15** with a wire **16** connected at one end to and leading from each terminal, and its other end terminating as a pin-shaped recording electrode **17** projecting from face **12** in a linear array, as indicated in FIG. 7.

In the present instance, connector units **13** and **14** are arranged one above the other (FIGS. 2 and 3) with all wires **16** meeting in a common row formed by passing them over a dowel **20** in spaced parallel relation with each other throughout the length of body extension **11**. Thus the molded assembly includes in one portion thereof, six rows of fanned out wires **16** (FIG. 3) each row being in a transverse plane angularly spaced from each other, and all concentrated at another portion of the assembly in a single planar row. According to the present illustrated embodiment, even though eighty-two terminals are provided by connector units **13** and **14** only seventy-seven wires are used to form the linear array of exposed electrodes **17**, some of which are shown in FIG. 7.

Further, for a clear understanding of the critical nature of the assembly, it is to be understood that each wire has a diameter of the order of 0.003 of an inch. Proper parallel spacing of the wires is obtained by forming accurately spaced wire seating grooves in the dowel **20**, as described later during the description of the method of fabrication.

Referring to FIG. 1 illustrating a use of the head for electrostatic printing or the like, the recording head of the invention is arranged with the linear array of electrodes adjacent to a recording medium **21**, in tape or sheet form, which is moved across the electrodes by means (not shown), but during which movement it is guided by suitable rollers **22** and **23** located on the opposite sides of a printing anvil **24** in such a way that the sheet **21** passes the electrode array in a direction normal to the alignment of the electrode array. Illustratively, spacing of the electrodes from medium **21** is of the order of a few thousandths of an inch. For a more complete description of electrostatic printing apparatus wherein the present invention may be utilized, reference may he had to co-pending United States application, entitled "Electrographic Printer," Serial No. 443,646, filed July 15, 1954, in the names of H. Epstein and F. Innes, now Patent No. 3,012,839.

A novel method for performing the steps of fabrication resulting in the complete head is set forth in detail in the earlier mentioned co-pending application Serial No. 609,431 and is described herein as one method and apparatus for producing the article herein claimed, namely the recording head. To this end there is provided an open top receptacle or mold **25**, formed, as shown most clearly in FIG. 5, by removable side walls **26** preferably of metal stock, a floor **27** shaped to produce the desired molded head contour, and an end panel **28** of dielectric material, the latter being cut from a larger piece **28*a*** of such material as will be explained presently. The floor **27** provides a horizontal surface **27*a*** and downwardly inclined surfaces **29** and **29*a*** at opposite sides thereof.

Dowel 20 of dielectric material, having its ends fixed in walls 26, is positioned in the mold at the junction of walls 27*a* and 29. Mounted on inclined wall 29*a* as by angle irons 30, is a platform 31 having upstanding rigid pins 32 which serve as anchoring means during tensioning of the wires. The bottom of dowel 20 rests in a transverse arcuately shaped groove in the receptacle floor at the junction of the two surfaces 27*a* and 29, and is provided with wire spacing means comprising a row of peripheral grooves 33, FIGS. 4 and 5, each receiving one of the wires. V-grooves enable use of different wire diameters.

In order to facilitate handling and alignment of the multiplicity of fine wires 16 in an orderly array prior to their attachment to the molding fixture, connectors 13 and 14 are inserted and secured in suitable fashion, as by gluing, in apertures 13' and 14' in a thin sheet of dielectric material 28*a* (FIG. 2). Individual wires 16, are knotted at one end and thereafter soldered to one of the connector terminal pins 15, after which the opposite ends are secured in orderly array in the numbered slits 17 across the top of the dielectric sheet.

Sheet 28*a* is then placed in the jig as shown fragmentarily by the phantom outline 28*a* in FIG. 5. Thereafter individual wires are removed from the slits and secured to one of the pins 32, by means of a spring 37, after which the excess material of sheet 28*a* is cut away leaving panel 28.

As seen in FIG. 5, when panel 28 is in position, terminals 15 are below dowel 20 and preferably below a plane parallel with and above floor 27*a*. In stringing the wires, each is brought upwardly and over dowel 20 across floor 27*a* and over a second dowel 34 transversely arranged across the outer end of floor 27*a*. Preferably dowel 34 is formed with an outer brass sleeve having a row of peripheral grooves 35, equal in number to those in dowel 20 and aligned therewith to maintain uniform spacing of parallel wires. Illustratively, the axial spacing of both sets of grooves 33 and 35 may be of the order of twenty thousandths of an inch center to center.

To tension wires 16 (only one being shown in FIG. 5), each is led from dowel 34, downwardly over floor 29*a*, platform 31 and is connected by means of a clip 36 to a coil tensioning spring 37 attached to one of the pins 32. A selected applied tension by each of the springs 37 is of the order of one pound.

An inverted channel-shaped member 38, shown most clearly in FIG. 8, extends across the mold between walls 26 in close proximity to dowel 34. A pair of U-shaped members 33—33 adapted to be fitted over the upstanding projections 39—39 of the member 38 thus provide a slot or aperture through which the wires 16 can be passed leaving a 1/32" clearance. The member 38 extends transversely of said mold and parallel to the dowel 34 at the required level to permit all of the tensioned wires 16 to pass through an exposed body of grease 40, such as Dow Corning silicone grease which fills the member 38 and together with the members 33—33 forms a dam at this end of the mold to prevent the molding material from running out.

After all of the wires are attached to pins 32, the aforementioned liquid resinous material is poured into the mold cavity formed by the floor 27, and walls 26, such pouring being a step-by-step operation starting in the area of the inclined floor 29 thus to form a composite body of successive layers. As each layer is poured to its selected thickness, it is allowed to cool slightly before adding a succeeding layer. Thus, layer by layer the body grows, passing over dowel 20 to flow onto the horizontal floor surface 27*a* until approximately one-sixteenth of inch below the plane of the stretched wires 16. With the cooling of this layer, pouring continues until the material reaches a level approximately 1/16" above the stretched wires, and then it is allowed to cool slightly. This cooled layer is now covered with another layer of one-sixteenth thickness and also allowed to cool slightly.

The final layers of material are now poured one after another until the extension 11 has the required thickness to locate the row of electrodes medially thereof. The layer pouring and particularly of the two layers of one-sixteenth inch thickness immediately above and below the plane of wire prevent the formation of bubbles about the wires, and the build-up of internal stresses as well as reducing shrinkage of the plastic molding material. Electrical arc-through in the bubbles due to gas formation therein would tend to cause carbon tracks in the plastic material shorting the wires 16 together.

When the molding operation is complete, the mold is dismantled thus to release the molded head, after which the extension is cut off transversely in close proximity to dam 38, thereby exposing the array of electrodes for final processing as exposed pointed pin members. Also as seen in FIGS. 3 and 4 dowel 20 is trimmed down to conform to the molded contour of the body of the head.

The wire ends are or may be abraded in suitable fashion as with a pig bristle brush to remove the excess plastic material adhering thereto since the plastic tends to expand beyond the tips of the exposed wires.

It will now be apparent that a complete unitary electrostatic head has been devised, resulting in a head construction wherein a multiplicity of pre-stressed accurately spaced leads are so arranged as to form a single linear array of exposed electrodes.

What is claimed is:

1. An electrostatic recording head, comprising a body of insulating material having a flat relatively thin extension at one end and a relatively thick portion converging into said extension, a panel molded into the outer face of said portion, a row of terminals extending through said panel below a plane through said extension, a dowel of dielectric material embedded in said body at the junction of said portion and said extension, and a plurality of conducting wires embedded in said body, each having one end connected to a selected terminal, an intermediate portion passing over said dowel, and its other end terminating in an array of electrodes projecting from the end of said extension.

2. An electrostatic printing head according to claim 1 wherein the dowel has transverse wire receiving slots for spacing the wires one from another.

3. An electrostatic recording head, comprising a body of insulating material having a flat relatively thin extension at one end and a relatively thick portion converging into said extension, a dielectric panel molded into the outer face of said portion, a row of terminals extending through said panel below a plane through said extension, a dowel of dielectric material embedded in said body at the junction of said portion and said extension, and a plurality of conducting wires embedded in said body, the ends of said wire being fanned out vertically and horizontally and each being connected to a selected terminal, an intermediate portion of each wire passing over said dowel, and the opposite wire ends terminating in an array of electrodes projecting from the end of said extension.

4. An electrostatic recording head, comprising a body of insulating material having a flat relatively thin extension at one end and a relatively thick portion converging into said extension, a panel molded integrally with the outer face of said portion, a row of terminals extending through said panel below a plane through said extension, a dowel of dielectric material embedded in said body at the junction of said portion and said extension, and a plurality of conducting wires embedded in said body, each having one end connected to a selected terminal, an intermediate portion passing over said dowel, and its other end terminating in an array of electrodes projecting from the end of said extension, the opposite ends of each wire passing over said dowel in opposite angular directions relative thereto thus to maintain said wires under tension respect to their electrode and terminal ends respectively.

5. An electrostatic recording head comprising, a body of dielectric material having a relatively thin extension terminating in a recording end and a relatively thick portion terminating in a connecting end, said portions converging together to form an intermediate relatively straight line portion, a dielectric terminal supporting member molded into the outer face of said thick portion and including a plurality of electrical connectors thereon, portions of each connector extending through said terminal supporting means into said body below a plane through said extension, a dielectric member embedded in said body at the junction of said thin extension and said thick portion and extending transversely thereacross, and a plurality of electrical connectors embedded in said body, one end of each conductor being connected to a selected connector, the intermediate portion of each conductor passing over said dielectric member with a portion of each conductor on one side of said dielectric member being being angled away from the portion of the conductor on the opposite side of said dielectric member, the other end of each conductor terminating in an electrode forming a recording stylus at said recording head.

6. An electrostatic recording head comprising, a

plurality of rows of tensioned lead wires terminating at one end in an array of electrodes arraged in parallel spaced apart relation one with another, terminals attached respectively to the other ends of said wires, a dielectric dowel for converting said rows of wires into a common plane, and an insulating material molded around and about said wires and said dowel thereby embedding the same therein.

7. An electrostatic recording head comprising, a plurality of rows of tensioned lead wires terminating at one end in an array of electrodes arranged in parallel spaced apart relation one with another, terminals attached respectively to the other ends of said wires, a dielectric dowel for converting said rows of wires into a common plane, said dowel being provided with a plurality of transverse slots effectively spacing said wires in said common plane one from another, and an insulating material molded around and about said wires and said dowel thereby embedding the same therein.

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