United States Patent

Lloyd

[15] **3,693,185**

[45] **Sept. 19, 1972**

[54] ELECTROSTATIC RECORDING HEAD

[72] Inventor: **William A. Lloyd**, San Jose, Calif.

[73] Assignee: **Versatec, Inc.**, Cupertino, Calif.

[22] Filed: **Oct. 15, 1970**

[21] Appl. No.: **81,073**

[52] **U.S. Cl.** .....**346/139 C**, 29/592, 346/74 ES

[51] **Int. Cl.**.....**G01d 15/06**

[58] **Field of Search** .....346/139 C, 74 ES; 29/592

[56] **References Cited**

UNITED STATES PATENTS

2,974,368	3/1961	Joyce	29/592
3,124,804	3/1964	Johnson et al.	346/74
3,157,721	11/1964	Barish	264/157

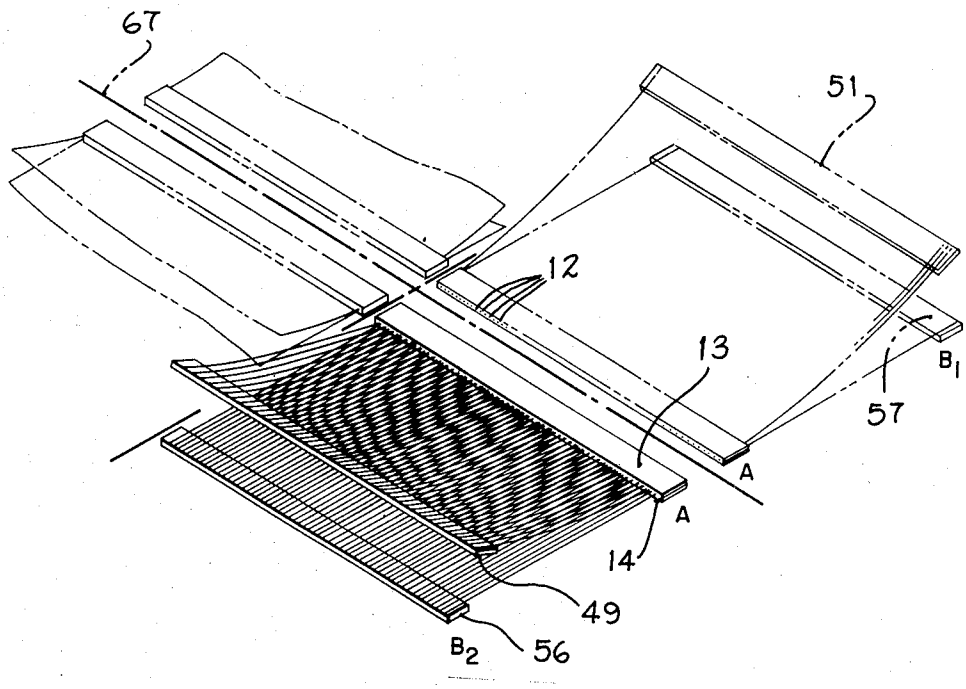
Primary Examiner—Joseph W. Hartary

Attorney—Flehr, Hohbach, Test, Albritton & Herbert

[57] **ABSTRACT**

Electrostatic recording head constructions comprise a first and second series of conductors disposed in spaced, parallel relation and having a pair of elongated, insulative head members secured together in confronting relation sandwiching one end of each of the conductors therebetween. The tips of the conductor ends are exposed in a line lying substantially in a plane between said members. Finally, first and second elongated handling elements are readily releasably secured respectively to the other ends of the first and second series of conductors.

1 Claim, 8 Drawing Figures



PATENTED SEP 19 1972

3,693,185

SHEET 1 OF 2

FIG_1

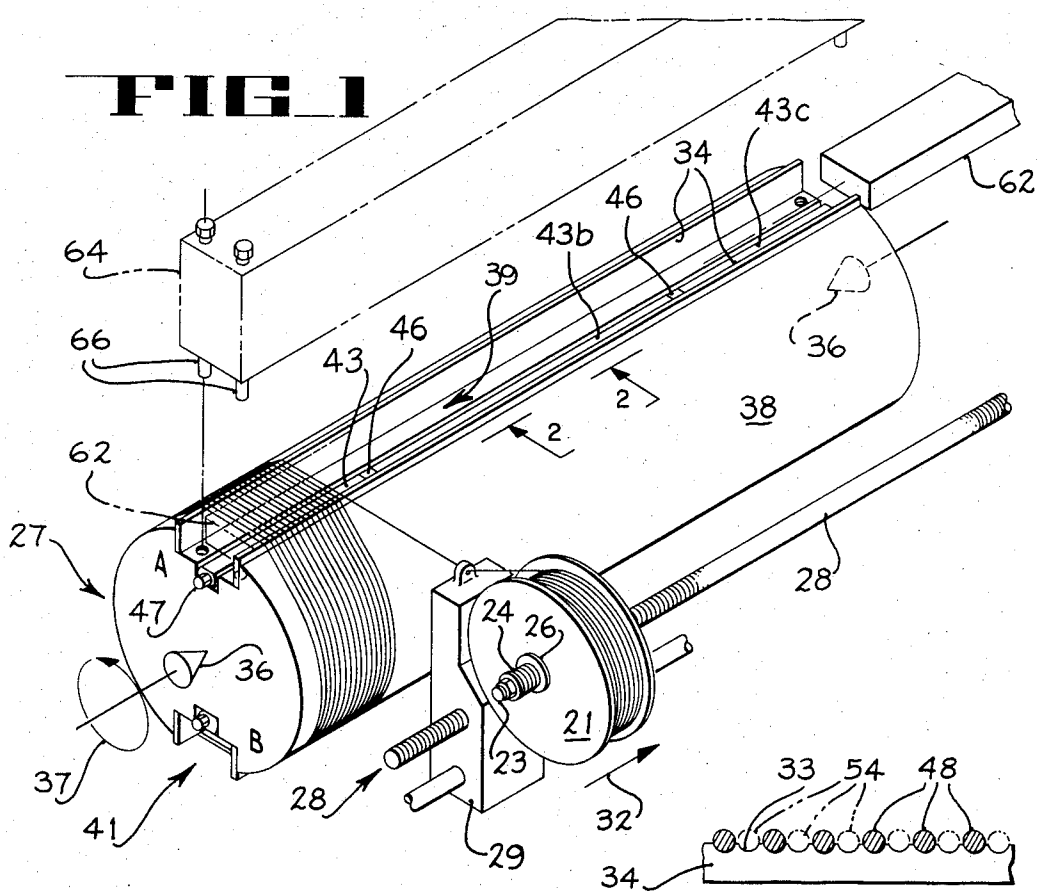


FIG_2

FIG_3

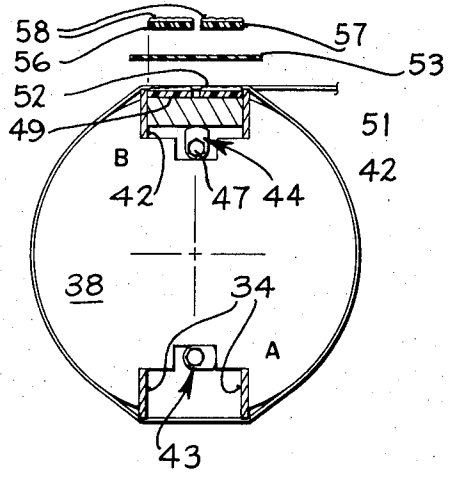
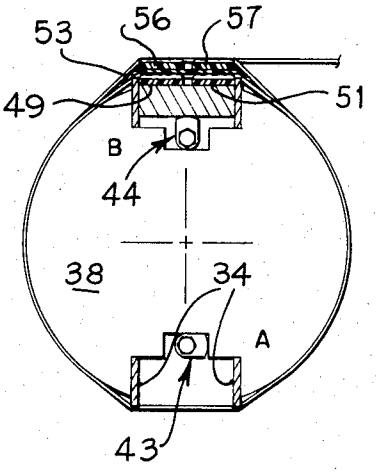


FIG_4

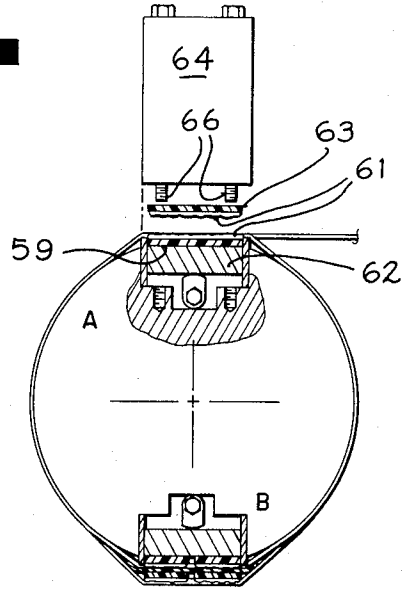


INVENTOR.
WILLIAM A. LLOYD

BY Flehr, Hohbach, Test, Albritton & Herbert

ATTORNEYS

FIG_5



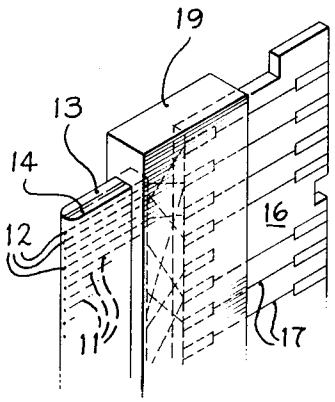


FIG_8

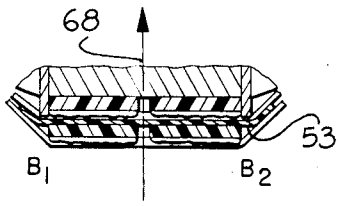


FIG_6

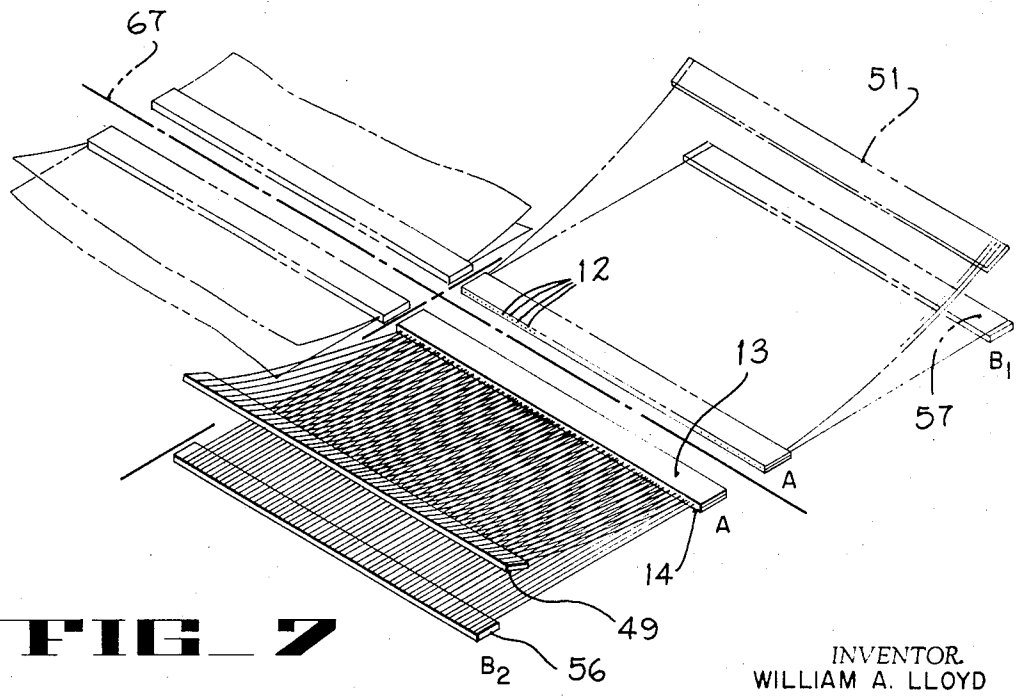


FIG_7

INVENTOR.
WILLIAM A. LLOYD

BY Flehr, Hohbach, Test, Albritton, & Herbert
ATTORNEYS

ELECTROSTATIC RECORDING HEAD

BACKGROUND OF THE INVENTION

This invention pertains to electrostatic recording "-head" constructions useful as a transducer in recording by electrostatic techniques on a web of material, such as paper, and further pertains to a method of manufacturing such a head construction.

In the technique of electrostatic recording, tiny dots are recorded in various configurations, for example, to provide alphanumeric characters, graphs, and the like. The close spacing of these dots requires that the recording head be provided with closely spaced electrostatic nibs or tips. These closely spaced nibs must, however, be independently electrically controlled and, accordingly, connections to these nibs must be made by suitable means.

Thus, it has been a typical problem to provide a head construction in a manner whereby electrical connections to the transducer nibs can readily be made.

SUMMARY OF THE INVENTION AND OBJECTS

In general, there is provided a method of making a transducer for electrostatic recording, including the steps of winding a length of wire about a drum to form a first series of uniformly spaced convolutions about the drum, underlaying the convolutions with an elongated strip of insulative material coated with an adhesive material, the strip extending transversely to the direction of the convolutions, and then moving the coated strip radially outwardly of the drum to urge the adhesive material against portions of the convolutions. These steps are then followed by applying a second series of wire convolutions about the drum, the convolutions of the second series each being flanked by convolutions of the first series. Subsequently, another strip of insulative material is adhered to the convolutions in a disposition confronting the first named strip so as to sandwich portions of said convolutions between the confronting strips. Subsequently, the strips are compressed tightly together followed by a period permitting the adhesive material to harden. Ultimately, the convolutions and strips are severed by cutting through the strips and also the portions of the convolutions contained between the strips, the cutting being done along a line extending lengthwise of the strips.

In the foregoing, there is provided an improved head construction and as will be pointed out further below, additional steps are added to the method in order that the head construction can be readily manipulated in the further connecting of the conductors during the critical and difficult stage of manufacture where the conductors are connected to lead-in wires.

Utilizing the foregoing method, it is readily evident that an electrostatic recording head construction can be provided of a type including a series of conductors disposed and spaced in parallel relation between a pair of elongated, insulative head members secured together in confronting relation sandwiching end portions of the conductors, whereby the tips of the conductors are exposed in a line between the insulative members. A printed circuit board is prepared with discrete conductive portions electrically connected to the conductors for recording via said tips. Finally, means enclosing the conductors supports the printed circuit board and head members noted above as a unitary assembly whereby the head can be coupled into a recording system by connections made to the conductive portions of the printed circuit board.

In general, it is an object of the present invention to provide an improved electrostatic recording head and method of making same, and wherein the construction is readily manipulatable during the critical connecting stage of its manufacture.

The foregoing and other objects of the invention will be more readily apparent from the following detailed description of a preferred embodiment when considered in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic perspective view of apparatus for making an electrostatic recording head according to the invention;

FIG. 2 is a section taken along the line 2—2 of FIG. 1 diagrammatically showing, in enlarged detail, detail of the combs utilized to provide spacing for the windings being applied;

FIGS. 3 and 4 are respectively diagrammatic end elevation views partially in section representing two stages in the manufacture of the connectable ends of the conductors;

FIG. 5 is a diagrammatic end elevation view partially in section showing one stage in the manufacture of the transducer head of the assembly according to the invention;

FIG. 6 shows, in enlarged detail, the lower portion of FIG. 5;

FIG. 7 is a perspective view diagrammatically showing a step in the manufacturing process for making the head construction according to the invention;

FIG. 8 is a diagrammatic perspective view showing a head assembly according to the invention;

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. 8 discloses a head assembly 10 according to the invention. Thus, a series of conductors 11 are disposed in parallel relation to provide the slightly exposed recording nibs 12 carried between a pair of elongated insulative head members 13, 14 of suitable semi-rigid or rigid material, such as fiber glass, secured together in confronting relation so as to sandwich end portions therebetween of the conductors 11. The tips or nibs 12 are exposed in a line extending between the members 13, 14 for recording, for example, across a moving web of paper or the like. The other ends of conductors 11 are connected to a printed circuit board 16 prepared with the usual discrete conductive portions 17 or leads formed along one edge of board 16 to include a series of connector tabs 18. The conductive lead portions 17 of board 16 are, accordingly, connected, as by soldering, to the ends of conductors 11 in known fashion for recording via the nibs 12.

After making the connections, an envelope 19 or other means is provided to enclose the conductors 11 in the region where their connections are made to the conductive leads 17. Thereafter a hardenable insulative material, such as epoxy, is disposed in fluid form to fill the envelope so that upon setting, the hardenable material serves to bond the entire assembly together in a substantially rigid form. The well known epoxy resins

are suitable whereby the assembly shown in FIG. 8 becomes a substantially unitary construction.

Having in mind the foregoing electrostatic recording head construction, its method of manufacture will now be readily apparent from the following diagrammatic description of FIGS. 1–7.

Initially, a spool 21 of wire 22 is supported in suitable style for rotation about a stub shaft 23 subject to a relatively light restraint applied to its rotation by means of the coil spring 24 disposed to press a washer 26 against the side face of spool 21. As thus arranged, a relatively modest drag is applied to wire 21 as it is wrapped about a rotatable drum assembly 27. While drum assembly 27 is rotated and wire 22 fed from spool 21, a lead screw 28 serves to advance a guide block 29 and its associated feeding eyelet 31 in the direction of arrow 32 at a rate whereby wire 21 will be laid into every other groove 33 of a pair of spaced comb elements 34.

As shown in FIG. 1, drum assembly 21 is arranged for rotation as schematically represented by the conical point supports 36 and rotated by suitable drive means represented schematically by the arrow 37. As thus arranged, drum assembly 27 can be supported in conventional manner, such as in a lathe or other conventional equipment for rotating a mandrel.

Drum assembly 27 comprises a generally cylindrical elongated drum member 38 formed to include diametrically disposed elongated channels 39, 41. Channel 39 is used in the formation of the transducer portions of the head structure whereas channel 41 plays its part in forming the connector ends of the head assembly during an intermediate stage of its construction as shown best in FIG. 7. For purposes of explanation and ease of reference, channel 39 is labeled with the capital letter A and channel 41 by the capital letter B in the diagrams.

Channels 39, 41 are bounded along their side edges by comb elements 34 and 42 respectively. Comb elements 34, 42 are secured by means (not shown) suitable for maintaining them in spaced parallel relation along their respective channels 39, 41.

Centrally along each of channels 39, 41, rotatable cam assemblies 43, 44 respectively are arranged to be rotated 90° for purposes described further below in carrying out the method.

Each cam assembly 43, 44 is constructed in the same manner to include longitudinally disposed, substantially tandem cam sections, e.g., 43*a*, 43*b*, 43*c* supported for rotation by small pillow blocks 46 or other type of journal member and rotatable from an end by means of the hexagonal nut 47 formed on the outer end of cam section 43*a* and extending by a connecting rod (not shown) to each of the other sections.

Having in mind the foregoing structure for the manufacture of head assemblies 10, it will be readily evident that four or more head constructions of suitable length as shown in FIG. 7 can be manufactured as now to be described.

Initially, the first step is to wind a length of wire 22 about drum assembly 27 to form a first series of uniformly spaced convolutions 48 about the drum assembly utilizing every other one of the grooves 33 formed in combs 34, 48.

As herein described, the head constructions shown in FIG. 7 are each produced in a manner providing readily manipulatable lead-in wires on the connecting ends of the conductors. In order to provide these manipulatable lead-in wires, and thereby speed manufacture and accuracy of connections made, the first series of convolutions 48 are underlaid in channel 41 with a pair of elongated strips 49, 51 coated with adhesive material 52 disposed between strips 49, 51 and portions of convolutions 48. It will be readily evident that this arrangement is provided at a location arcuately removed from the wire portions crossing channel 39.

The next step is to urge strips 49, 51 radially outwardly of drum member 38 by rotating cam assembly 44 to the position shown in FIG. 3 so as to press the adhesive material 52 against the adjacent portions of convolutions 48 spanning channel 41. Then an elongated separator strip 53 of a material, such as Teflon, which is characterized as being generally nonadherent to the adhesive 52 but may be carried by adhesive 52 (though readily releasable therefrom) is disposed to overlay strips 49, 51 and those portions of convolutions 48 spanning channel 41.

Subsequently, a second series of convolutions are applied about drum member 38 to extend across both separator strip 53 and strips 49, 51 at channel 41. At channel 39, the second series of convolutions 54 will be each flanked by convolutions 48 of the first series.

Then, while supporting a pair of elongated strips 56, 57 of compliant semi-rigid material upon separator strip 53 while applying the second series of convolutions 54 across both separator strip 53 and strips 56, 57, the portions of convolutions 54 bridging channel 41 will be disposed in the adhesive 58 carried by strips 56, 57.

With respect to channel 39 (where the transducer head is being prepared) it has been noted above that the second series of wire convolutions 54 are applied alternately with respect to convolutions 48 by means of the combs 34 located in channel 39. Convolutions 48 and 54 are underlaid with an elongated, flat head member or strip 59 (FIG. 5) of semi-rigid insulative material, such as fiber glass.

Strip 59 is coated with a suitable adhesive bonding material, such as epoxy 61. Strip 59 extends transversely to the direction of the convolutions and, accordingly, lies along the channel 39 resting upon a lower clamping bar 62.

Clamping bar 62 is inserted into channel 39 while cam assembly 44 for channel 39 is laid to one side by rotating its nut 47. At the same time, strip 59 is carried along channel 39 supported by bar 62 at a level beneath the bridging portions of convolutions 48 and 54.

Subsequently, according to the method herein described, the strip 59 is moved radially outwardly of drum member 38 to urge the adhesive material 61 against the channel-bridging portions of the convolutions. A second head member or strip 63 of fiber glass, also coated with epoxy material, is then adhered to the first to sandwich portions of the convolutions 48, 54 between the two strips 59, 63. The further step is then provided of compressing the two strips 59, 63 tightly together by means of the upper clamping bar 64 using the threaded bolts 66 located in each end thereof. Bolts 66 enter threaded openings formed in the ends of channel 39 and by tightening the bolts uniformly at each

end, the wire will be firmly bonded between the two strips of fiber glass having a semi-rigid construction. Next, the adhesive epoxy material is permitted to harden and then the final step is accomplished of severing the convolutions and strips by cutting through the strips **59**, **63** and through the bridging portions of convolutions **48**, **54** lengthwise of the strips (FIG. **7**), i.e., as along the phantom line **67**.

Subsequently, (FIG. **6**) a cut is made along the phantom line **68** through the separator strip **53** and those portions of convolutions **48**, **54** extending across channel **41**.

In this form, an electrostatic recording head construction has been provided as shown in FIG. **7** comprising a first and second series of conductors disposed in spaced parallel relation together with a pair of elongated insulative head members **13**, **14** secured together in confronting relation sandwiching end portions therebetween at one end of each of the conductors. The tips or nibs **12** of the ends are exposed in a line lying substantially in a plane between members **13**, **14**. First and second elongated handling elements in the form of the strips **49**, **56** are readily releasably secured respectively to the other ends of the two series of conductors so that the ends of the wires to be connected can be readily peeled from these strips.

Accordingly, the product shown in FIG. **7** can then be readily handled by a technician employed to solder the releasable ends attached to strips **49**, **56**, for example, to the printed circuit board **16** while preventing entanglement of the remaining wires of the assembly.

I claim:

1. An electrostatic recording head construction comprising a first and second series of conductors disposed in spaced parallel relation, a pair of discrete, preformed elongated, insulative head members secured together in confronting relation sandwiching end portions therebetween of one end of each of said conductors, the tips of said ends being exposed in a line lying substantially in a plane between said members, and first and second elongated strips of insulative material, and means for readily releasably holding the other ends of said first and second series of conductors respectively to a side surface of said strips, said strips being movable independently of each other to permit placement thereof variously as desired.

* * * * *