

[54] **METHOD OF MANUFACTURING
ELECTROMECHANICAL VIBRATION
PICK-UPS**

[75] Inventors: **Lucien Lainez; Fokke Duiker; Jöel Bayard; Dominique Di Campli**, all of Paris, France

[73] Assignee: **Thompson-Brandt**, Paris, France

[22] Filed: **Oct. 9, 1973**

[21] Appl. No.: **404,783**

[30] **Foreign Application Priority Data**

Oct. 10, 1972 France 72.35857

[52] U.S. Cl. **29/169.5; 29/481; 29/591;**
29/592; 29/610 SG; 219/121 LM; 274/23 R

[51] Int. Cl. **B29d 17/00**

[58] Field of Search 29/169.5, 610 SG, 592,
29/589, 590, 591, 481; 219/121 LM, 121
EM; 274/23 R

[56] **References Cited**

UNITED STATES PATENTS

3,474,526	10/1969	Shoor.....	29/592 X
3,632,398	1/1972	Konig.....	219/121 LM X
3,698,074	10/1972	Helda et al.	29/481 X

3,766,616 10/1973 Staudte 29/592 X

Primary Examiner—C. W. Lanham

Assistant Examiner—Victor A. DiPalma

Attorney, Agent, or Firm—Edwin E. Greigg

[57] **ABSTRACT**

Electromechanical vibration transducers or pick-ups of this kind are manufactured from a single beam of ceramic material having at least one flat face provided with a deep slot at about its middle, separating it into two portions. This slot is being bridged by means of a transistor-type electromechanical transducer whose extremities are respectively fixed to the flat faces of the first and the second beam portions, one of which is mounted in a damping block and the second of which carries a pick-up stylus. After the mounting of the transistor and the stylus, the assembly is inserted into a protective housing from which only the stylus protrudes through an opening and the two beam portions are completely separated by cutting through the base of the slot, so as to become interconnected solely by means of the transistor substrate. The means preferably used for this cutting operation is a laser beam made to pass through the protective housing.

10 Claims, 9 Drawing Figures

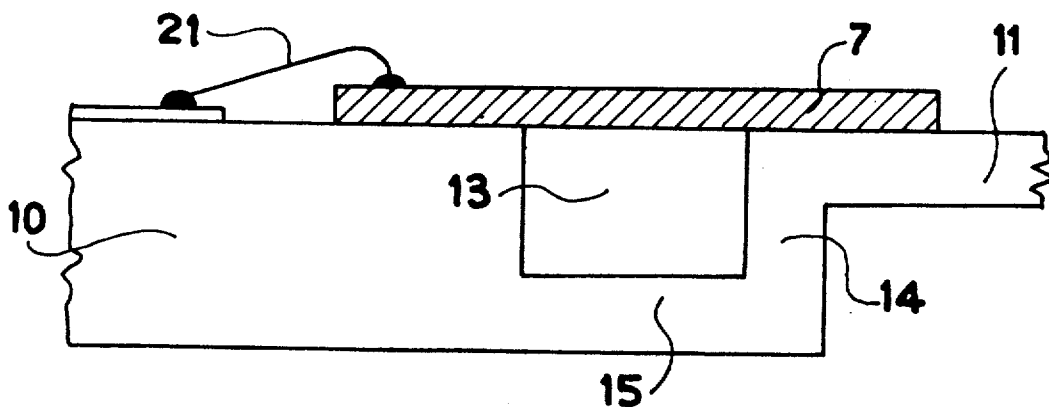


FIG. 1

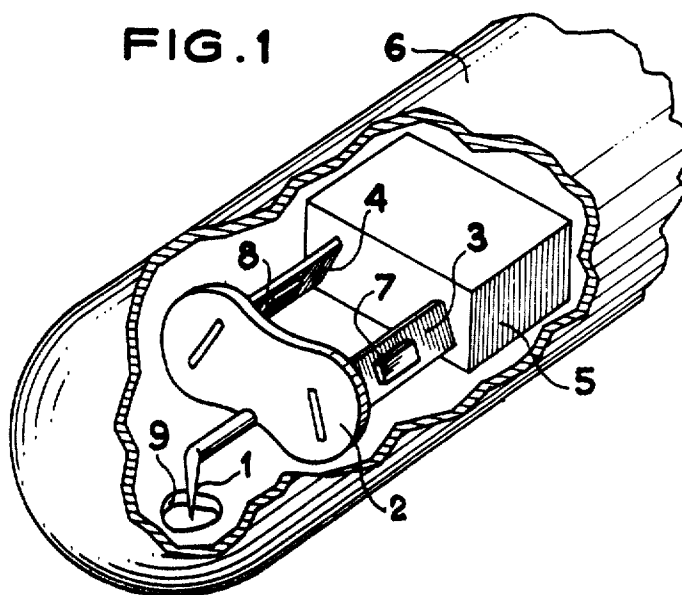


FIG. 2

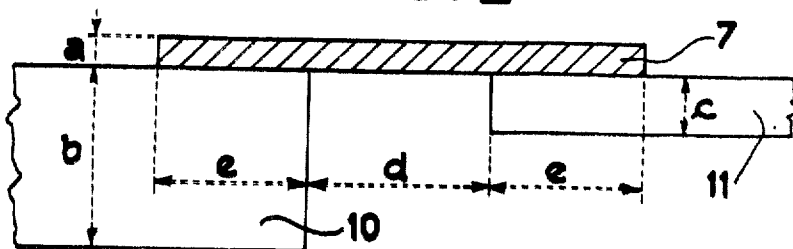


FIG. 3

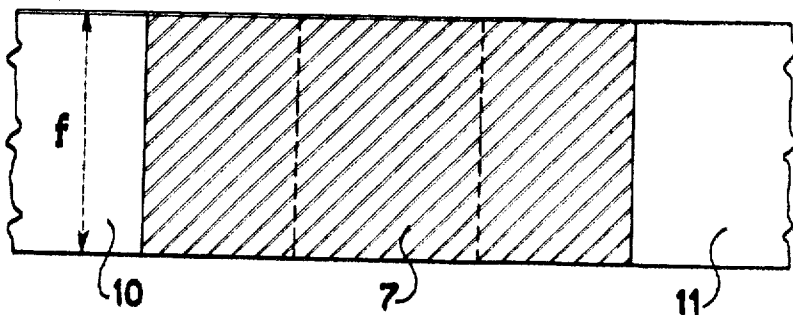


FIG. 4

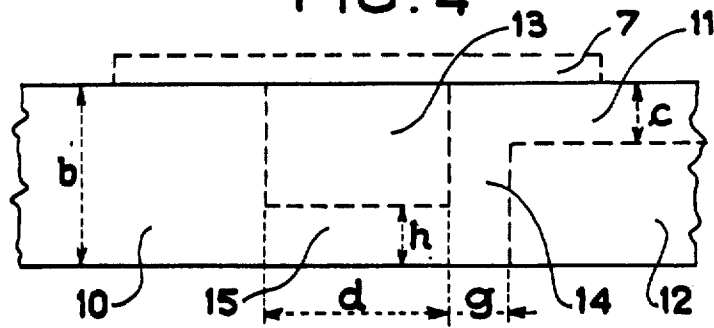


FIG. 5

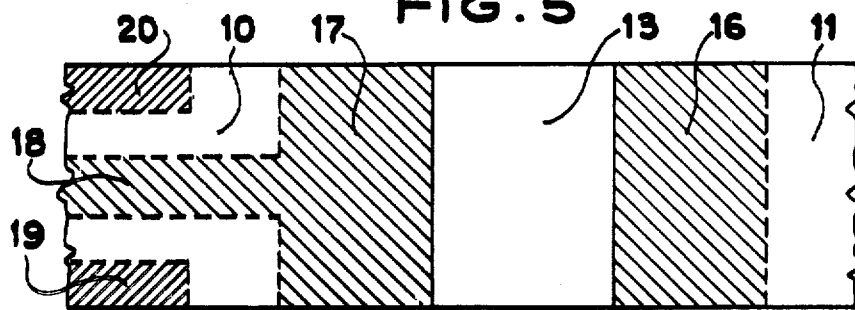
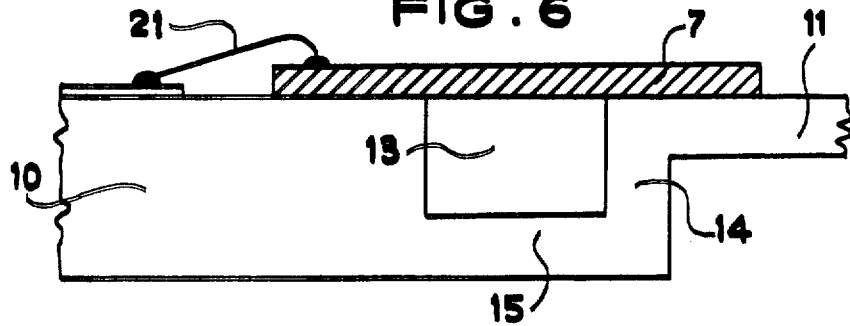
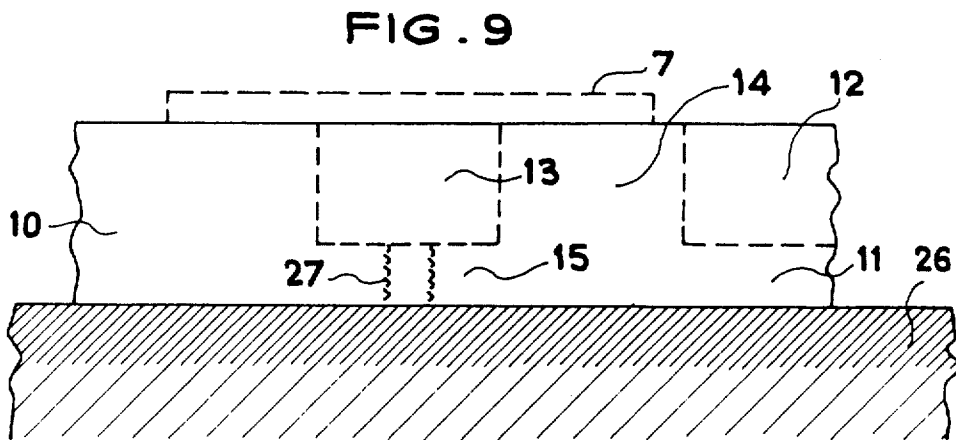
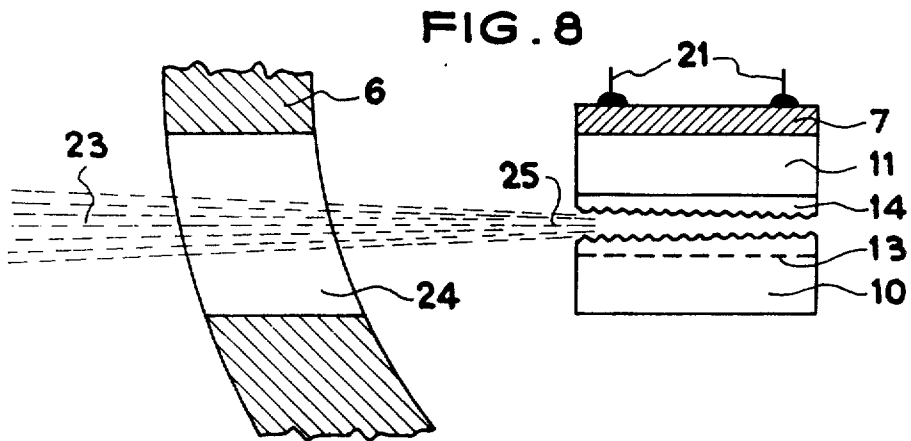
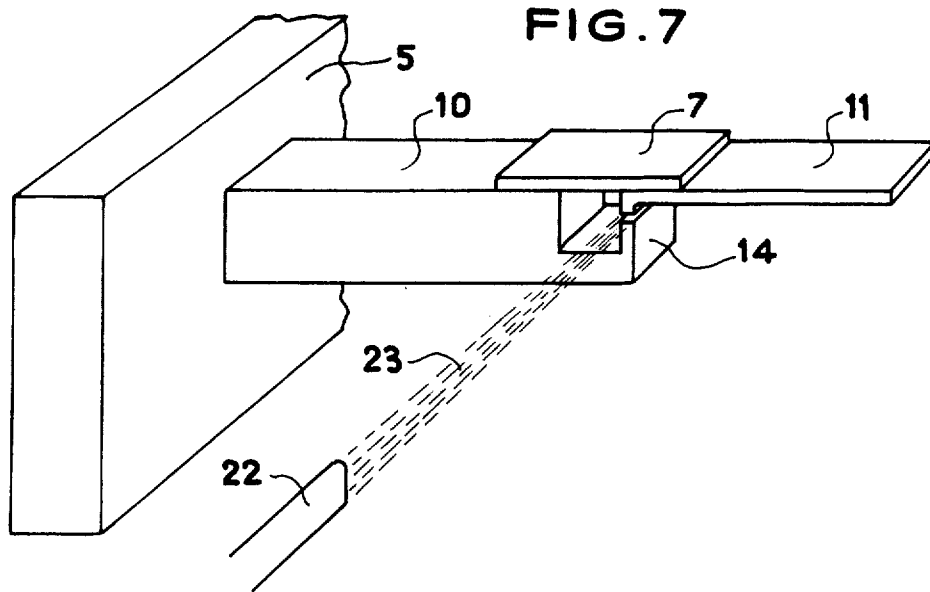


FIG. 6





METHOD OF MANUFACTURING ELECTROMECHANICAL VIBRATION PICK-UPS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to methods of manufacturing electromechanical vibration pick-ups and to the pick-ups thus obtained, and more particularly to methods of manufacturing the pick-up heads used with record discs, in particular stereophonic record discs, utilising semiconductor strain gauges, as well as to pick-ups of this type obtained by means of this method.

2. Description of the Prior Art

A pick-up head of the stereophonic which may be manufactured by this method is made up in a general way (see FIG. 1) of a stylus 1 resting upon a coupler 2 of plastic material for example said coupler 2 being integral with two beams 3 and 4 of ceramic material, for example alumina, forming an angle of 90° with one another and secured in a damper 5. Said damper 5 is itself attached to a base which has not been shown. The damper 5 (or the base to which it is attached) furthermore carries a protective envelope or housing schematically marked by the reference 6, containing the assembly of the foregoing components; a cut-away has been illustrated at the top, to expose the interior; an opening 9 gives passage to the end of the stylus-holder, enabling it to perform normal displacements but limiting the movements so that these latter are restrained from reaching an amplitude of sufficient magnitude to break the beams 3 and 4. Two transistors 7 and 8 acting as strain gauges, are attached to the beams 3 and 4 (or to a waisted portion thereof) or may act as bridges between two independent parts thereof. FIGS. 2 and 3 schematically illustrate the profile and a plan view showing the method of attachment of one of these transistors to a beam. The illustrations show a beam 3 (or 4) split into two portions, the built-in part 10 and the coupler portion (or stylus part) 11. The transistor 7 (or 8), is soldered or stuck at each of its ends to these two portions 10 and 11, linking them together. It can be seen that as a consequence of this arrangement, all the stresses transmitted by the coupler are borne by the transistor substrate which experiences a much greater distortion than if the transistor had simply been attached to a continuous beam. The sensitivity is further improved by reducing as far as possible the mass of the components located between the transistor and the stylus. This is why that portion of the beam located at the stylus side 11, has been thinned right down to the limit which strength considerations permit, whilst the portion 10 at the fixing side can have a much greater thickness. In FIGS. 2 and 3, by way of example, the major dimensions of a pick-up embodiment have been illustrated. All the dimensions are expressed in millimetres. The thickness a of the silicon monocrystal of the transistor, is around 0.2 mm, the portion 10 of the beam has a thickness of $b = 0.65$, whilst the thickness of the portion 11 is $c = 0.25$. The two portions of the beam 10 and 11 are spaced apart by $d = 0.6$, whilst the transistor 7 covers the ends of the portion 10 and 11 over a length $e = 0.5$. The width f of the portions 10 and 11 and of the transistor 7, is around $f = 0.8$.

The manufacture of this kind of device is difficult to achieve in a mass-production context. The dimensions of the components are such that they cannot be located

relatively each other with sufficient precision and processed accurately, for example, soldering of the silicon monocrystal to the ceramic requires a particularly flat surface. But above all, the assembly of the beam constituted by the two portions 10 and 11 connected together by the transistors 7, is extremely fragile. The thickness of the silicon monocrystal is only about 0.2 mm. Once assembly is complete, this fragility is no particular problem because, as mentioned herein before, the assembly is arranged inside a housing 6 and shielded from any shock loading, only the stylus projecting outside through an opening which is such as to limit the displacements of the stylus to a magnitude which the elasticity of the beams can withstand. This is far from being the case, however, during the large numbers of operations and handlings which this assembly has to undergo, e.g. soldering of connections, fitting into the damper 5, installation of the coupler 2 and of its stylus etc., etc., this number being extremely high for such a complex item of equipment, and the components having to be shielded from any shock loading throughout the whole course of the operations. This means that it is necessary to take precautions which are translated by waste of time in manufacture, and prohibitive prices.

SUMMARY OF THE INVENTION

One object of the present invention is a method of manufacturing an electromechanical vibration pick-up of the above-described type including a semiconductor type strain-gauge (transistor) connecting together two separate beam portions, and which makes it possible to overcome the difficulties associated with the fragility of the components being handled.

In accordance with one of its main features, the method consists essentially and successively in providing a beam having one flat face, in machining within said beam, at about its middle, a transverse slot perpendicular to said flat face, in fixing a transistor type transducer to said flat face astride said slot and in subsequently cutting through the residual thickness of said beam at said slot opposite said transistor, whereby said beam is separated into two portions connected together solely by the transistor which has previously been attached there.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and variant embodiments of the invention will become apparent during the course of the ensuing description of the method utilised, made with reference to the Figures in which:

FIG. 1 is an assembly view, in perspective, of a pick-up system;

FIG. 2 is a side elevation of a beam, complete with transistor;

FIG. 3 is a plan view of said same beam;

FIG. 4 is a side elevation of a beam prior to machining;

FIG. 5 is a plan view of a beam during machining;

FIG. 6 is a side elevation of a beam during machining;

FIG. 7 is a perspective view of a beam during machining;

FIG. 8 is an end elevation of a beam after machining;

FIG. 9 is a side elevation of a beam during machining in accordance with a variant embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The general design of the various components of a pick-up to be manufactured, has been described by FIGS. 1, 2 and 3.

FIG. 4 illustrates a ceramic beam such as 3 or 4, made for example of alumina, and marked 10 and 11, as in FIGS. 2 and 3, these two portions forming a single, identical component. After attainment of the desired thickness b , the portion 11 adjoining the stylus is machined by a likewise known method, in order to thin it down to the thickness c (FIG. 2). This thinned portion of the beam is marked 12 in FIG. 4. Then, again using a known method, for example using a diamond wheel, ultra-sonic machining or other technique, a transverse slot 13 is produced separating the stylus-side portion 11 from the fixing portion 10. This slot is not deep enough, however, to cut the beam into two portions: it stops at a point such that the distance marked h between the base of the slot 13 and the external edge of the beam, i.e. the residual thickness of the beam at the slot 13, is between around 0.2 and 0.3 mm. The width of this slot is around $d = 0.6$ mm. It can be seen that the two portions remain attached to one another but are in fact connected purely by a bridge piece of around 0.2 or 0.3 mm thickness located between the recessed portion 12 and the slot 13, marked 14 on the one hand, and the base of the slot 13 and the edge of the beam, marked 15 on the other (FIG. 4), the respective thicknesses of the connecting portions (h of 15 and g of 14) being sufficient to maintain the beam portions 10 and 11 integrally united.

The beam, in its integral state, is then prepared for the attachment to the transistor 7. The surfaces 16 and 17, located at either side of the slot 13 and given a flat finish with the desired precision, are covered with a gold film around one micron in thickness, by a known method. FIG. 5, which is a plan view of the beam from the slotted side, indicates in cross-hatched form the thus covered zones. It can be seen, in particular, that the zone 17, at the fixing side 10 of the beam, is extended at the centre in the form of a conductive film 18 designed to connect the zone 17 to leads, not shown, in the fixing block 5.

Concurrently with the production of the gold films 16 and 17, the latter being extended by the portion 18, there are produced at the same top surface of the beam, two leads 19 and 20, constituted by the deposition of a metal film on the ceramic surface. This metal film can be gold, or, and this is more economical, molybdenum. It can be seen from FIG. 5, that these leads are not in contact either with the lead 18 or with the zone 17, and extend up to the block 5, being subsequently connected to the electronic circuit of the system by leads which have not been shown.

The transistor 7 is subsequently soldered by a eutectic gold-silicon solder, to the beam, 10, 11 astride the slot 13, at least partially covering the surfaces 16 and 17 (FIG. 6). It will be seen that in this fashion the solidity of the beam is further reinforced between its portions 10 and 11 which are attached together both by the zone 15 and the transistor 7.

The beam is then supplemented by leads 21 between transistor 7 and the leads 19 and 20 respectively. It can be seen that the length of these leads 21 is reduced to the minimum, helping to make them stronger. Subse-

quently, the various operations and manipulations required to bring the pick-up to the final state which it has in FIG. 1, are carried out. In all these operations, the beam is still a mono-bloc or integral item, reinforced furthermore by the presence of the transistor 7 (or 8), and it will be seen that it can be manipulated using less stringent precautions, until the time at which it is finally protected by the housing 6. This considerably reduces the risk of strapping due to breakage of the beam, and consequently reduces the manufacturing cost.

In accordance with one feature of the method of the invention, in order that the portion 11 of the beam at the stylus side, shall not be connected to the base side portion 10 except by the silicon substrate of the transistor 7, the zone 14 of the beam constituted by the flank of the slot 13, is cut using a laser beam. FIG. 7 provides a schematic, perspective view of the relative dispositions of the various elements of the beam 10, 11, and of the laser 22. The latter is a known piece of apparatus, and requires no description here. An yttrium-garnet laser was used, producing an isochromatic light beam of around 8 mm diameter focussed by an optical system at a distance of around 25 mm. The laser 22, in relation to the beam 10 - 11 occupies a position such that its beam 23 is substantially perpendicular to the axis of the beam 10, 11 and parallel to the plane of the transistor. After having passed through an opening formed for the purpose in the housing 6, said beam strikes the zone 14 and cuts it, thus separating the two portions 10 and 11 of the beam which are connected together then by nothing more than the substrate of transistor 7.

FIG. 8 schematically illustrates an end elevation of the beam during machining by the laser. The transistor 7 and its two leads 21, the thinned portion 11 of the beam at the stylus side, and the portion 10 at the housing side, can be seen, the zone 14 is located between the bottom part of the beam 11 and the base of the slot 13 shown in broken line. The laser beam 23 passes through the housing 6 via the hole 24 and is focussed substantially at the centre of the zone 13. A sighting system of known reflex kind, facilitates the adjustment of the position of the beam on the zone 14. Cutting of the zone 14 is effected by melting the ceramic; a slight scanning motion on the part of the beam, in a plane parallel to the transistor (perpendicular to the plane of FIG. 8), makes it possible to produce a melted trench the whole width of the zone 14. This trench 25 shown in the form of a slightly wavy line in FIG. 8 is about 10 hundredths of a mm wide at the laser end and 5 hundredths of a mm wide at the end opposite the laser. This dimension is quite sufficient to enable the part 11 of the beam at the stylus side, to oscillate freely in relation to the part 10 at the housing side, without the two lips of this trench 25 touching. The duration of the operation of cutting the zone 14, is only a few seconds.

From the arrangement of FIG. 8 in particular, it can be seen that during the cutting operations, the fine droplets of molten ceramic which are inevitably projected in all directions are kept away from the transistor leads to a maximum extent, these leads being protected in this context by the transistor base itself and the portion 10 of the beam. After having passed through the zone 14, the laser beam passes through the whole interior of the housing and strikes the portion opposite the opening 24. The housing is generally pierced at this location by the laser beam itself, al-

though without this constituting any drawback. It will be observed that in accordance with the general arrangement of the components of the pick-up as shown in the FIG. 1, the laser beam encounters no obstacle which it could impair apart from the envelope 6.

A variant embodiment of this invention consists in simplifying to some extent the machining of the beam as described in FIG. 4. The execution of the operations of abrading or cutting the zones 12 and 13, is much easier and involves less risk of breakage of the ceramic, if the latter is stuck to a base, for example glass. The adhesive is readily dissolved after execution of the machining operations. In the operations described in FIG. 4, it can be seen that machining has to be carried out on both faces of the beam, which means that the beam can not be stuck to a base in order to be machined, or at any rate, if it is, the operations of sticking and unsticking have to be performed twice. In the variant embodiment shown in FIG. 9, the back of the beam 10, 11 is stuck to a base 26, for example of glass, and abraded by some known means in a zone marked 12 in broken line in the FIG. 9, in order to form the thinned portion of the beam, 11 at the stylus side. The slot 13 is likewise formed at the same side as the abraded portion 12. The position of the transistor 7 has been indicated in broken line, straddling the slot 13. After the execution of these operations, the beam is unstuck from the base 26 and assembled to form the pick-up as described in FIG. 1. The laser cutting is carried out as in the preceding case, but the trench, instead of being formed in the zone marked 14, is formed in the zone 15 where, in FIG. 9, the trench 27 has been shown separating the portions 10 and 11.

This last method has the drawback of giving the portion 11 of the beam which is at the stylus side, a slightly greater mass than that which it would have if it were machined by the preceding process. It will be seen, in other words, from a consideration of FIG. 9, that the portion 11 at the stylus side is made up not only of the thin portion but also of the whole of the zone 14 and part of the zone 15. Moreover, the zone 14 is thicker than the corresponding zone produced by the method of machining both faces. The result has slightly poorer qualities as far as vibrations at high frequencies are concerned, but the cost price is lower.

This last method can be utilized for units of ordinary quality, whilst the first method can be reserved for dearer units which have better performance.

A second variant embodiment can be applied in relation to the operations of metallising the top face of the beam 10, 11. In other words, it may be more economical to metallise the whole of this face and to produce different areas 16 - 17 - 18 - 19 - 20 by cutting the metal using ultrasonic techniques, a diamond wheel or some other known means.

What is claimed is:

1. A method of manufacturing an electromechanical vibration pick-up device comprising a stylus-holder assembled on at least one beam, said beam having at least one flat face and comprising a first portion to be fixed in a damper, a second portion for carrying a stylus-holder, and a transistor having a substrate respectively mechanically connected to said flat faces of said first and second beam portions, said method comprising the following steps:

forming a transverse slot on said flat face of said beam, said slot having walls;
securing said transistor substrate to said flat faces astride said slot; and subsequently
cutting through one of said slot walls to create a gap and thus to split the beam into two separate portions mechanically connected together solely by said transistor substrate.

2. A method as claimed in claim 1, wherein said cutting is carried out after having subjected the beam to at least a part of the assembly operations which are required to bring the pick-up device into its final state, posterior to said securing of said transistor substrate.

3. A method as claimed in claim 1, wherein the second beam portion bearing the stylus-holder is thinned by abrasion of said flat face and at such a distance from the neighboring sidewall of said slot, that the thickness thereof is sufficient for integrally and rigidly connecting said two beam portions together.

4. A method as claimed in claim 3, wherein the slot is formed after the second beam portion bearing the stylus-holder has been thinned.

5. A method as claimed in claim 1, wherein the second beam portion bearing the stylus holder is thinned by abrasion of the face opposite the flat one and at such a distance from the neighboring sidewall of the slot that its thickness is sufficient for maintaining the integrity and rigidity of said two beam portions.

6. A method as claimed in claim 5, wherein the slot is formed after the second beam portion bearing the stylus holder has been thinned.

7. A method as claimed in claim 5, wherein said cutting is performed in the sidewall of the slot adjacent to the abraded portion of said beam.

8. A method as claimed in claim 1, wherein said cutting is carried out by a laser.

9. A method as claimed in claim 1, wherein said transistor is secured to the beam by means of an eutectic gold-silicon.

10. A method as claimed in claim 1, wherein the pick-up device comprises in addition transistor leads, said method consisting in depositing metal layers on said flat face of the first beam portion, before cutting through said slot wall.

* * * * *