



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.05.2006 Bulletin 2006/18

(51) Int Cl.:
G11B 5/127 (2006.01) G11B 5/29 (2006.01)

(21) Application number: **05110115.2**

(22) Date of filing: **28.10.2005**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR**
Designated Extension States:
AL BA HR MK YU

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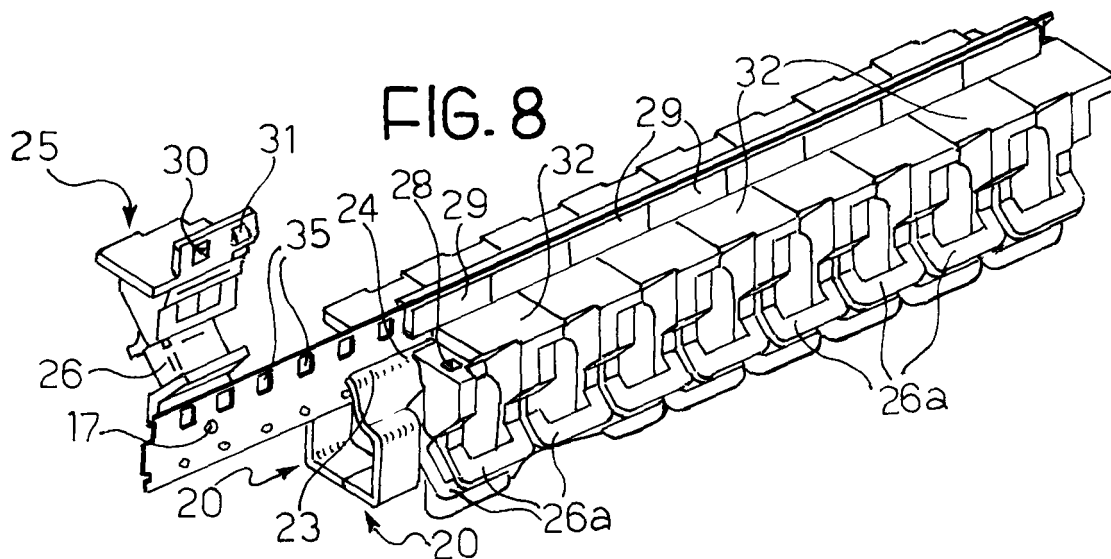
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(30) Priority: **29.10.2004 IT TO20040753**

(54) **Modular magnetic head for scanning magnetized strips or threads**

(57) The core of a head for scanning magnetized strips or threads comprises two half-cores (11, 12) elongate in a longitudinal direction and facing one another transversely. Each half-core (11, 12) has a forward end edge (15, 16) parallel to, and magnetically separated from a forward end edge (16, 15) of the other half-core in such a way as to define a longitudinal gap which constitutes the sensitive part of the head. Each half-core (11, 12) is composed of a plurality of modular half-core ele-

ments (20) longitudinally side by side with one another. Each modular element (20) has a forward portion (23) defining a section of the forward end edge (15, 16) of one of the two half-cores (11, 12). The forward portions (23) of the modular elements (20) belonging to one (11, 12) of the two half-cores are longitudinally staggered with respect to the forward portions (23) of the modular elements (20) belonging to the other (12, 11) of the two half-cores.



Description

[0001] The present invention relates to a magnetic head of the type defined in the preamble of claim 1. The magnetic head is intended for scanning a code stored on a strip of magnetic material, in particular - but not exclusively - a security thread incorporated within a banknote.

[0002] In a banknote, a security thread is disposed perpendicularly to a major side of a banknote, and extends for the entire width of the banknote, parallel to a minor side thereof. A known type of magnetic security thread is composed of a support strip which may be made of a flexible and impermeable plastics material, on which are deposited some areas of magnetic material such as, for example, iron oxides. To store the code (which unequivocally identifies the size or value of the banknote) on the security thread, a different amount of magnetic material is applied in the various zones of the thread, varying the thickness, the density or the extent of the area occupied.

[0003] Modern devices for verifying the authenticity of banknotes are generally provided with feed means for feeding a banknote in a direction substantially perpendicular to the magnetic security thread, and with a scanning head comprising a "gap" which constitutes the sensitive part of the head, for scanning the code stored in the security thread.

[0004] A magnetic head of known type comprises a core of magnetic material in the shape of an open ring composed of a pair of half-cores constituted by two profile sections of ferromagnetic metal sheet, elongate in a longitudinal direction and having substantially C-shaped opposed cross-sections; the rearward end edges are physically in contact in order to have magnetic continuity between the two half-cores. The forward end edges however are spaced by means of the insertion of a thin sheet of magnetically non-conductive material (e.g. copper), so that the two half-cores together constitute a ring magnetically opened in its forward part by a longitudinal gap which constitutes the sensitive part of the head. Onto each half-core is overmoulded a covering of electrically insulating material, and round this is wound a coil, the heads of which are connected to respective PINs disposed at the bottom. The whole constituted by the core and windings is immersed in a synthetic resin within a screening container made of permalloy, so that only the forward surface of the head, which has the gap, emerges from the screen. As is known, the passage of a magnetic security thread which moves perpendicularly to the gap generates, by magnetic induction, an electrical voltage in the coils which is made available at the PINs.

[0005] Hitherto, magnetic heads have been constructed by assembling two half-cores having a length corresponding to that of the head. This involves significant investment, since it is necessary each time to provide a different die for the shearing and bending of the sheets of the half-cores, and a different mould for overmoulding the layer of plastics material capable of electrically insulating the half-cores from the respective windings. The

problem is particularly acute in the field of devices for verifying the authenticity of banknotes, where it is necessary to construct heads which are different each time because of the range defined by the various positions which the security thread assumes within banknotes of different sizes.

[0006] It has also been proposed to produce the half-cores by placing longitudinally side by side with one another pairs of modular elements that are aligned and opposed transversely. This solution has proved disadvantageous owing to the fact that when the security thread passes through a point of discontinuity between two pairs of modular elements side by side, the electrical signals supplied at the output by the PINs are weak or incomplete, especially if the banknote advances through the scanning device in a position that is inclined with respect to the longitudinal direction of the head. In order to remedy this drawback, it is necessary to provide the scanning device with rather complicated electronics, capable of correlating and processing the partial signals supplied by the various PINs in order to obtain data capable of identifying the banknote.

[0007] It is an object of the present invention to produce a magnetic head capable of remedying the drawbacks mentioned above. In particular it is desired to produce, in a simple and economic manner, magnetic heads of any length, capable of providing accurate output data.

[0008] These and other objects and advantages, which will be more clearly understood hereinafter, are achieved according to the invention by a magnetic head as defined in the appended claims.

[0009] A description will now be given of a preferred but nonlimiting embodiment of the invention, with reference to the appended drawings, in which:

Figure 1 is a cross-section through a magnetic head according to the invention;

Figures 2 and 3 are perspective views, from different angles, of a modular element for producing the core of the head in Figure 1;

Figure 4 is a diagrammatic view, according to the direction of the arrow IV in Figure 1, of the arrangement assumed by the modular elements of Figures 2 and 3 in the head in the assembled state;

Figures 5A and 5B are perspective views from different angles, and on an enlarged scale, of a support for the modular element of Figures 2 and 3;

Figures 6A and 6B are perspective views from different angles, and on an enlarged scale, of the support of Figures 5A and 5B with a coil wound round same;

Figures 7A and 7B are perspective views from different angles, and on an enlarged scale, of the support of Figures 5A and 5B with a coil wound on and a modular element inserted; and

Figure 8 is a perspective view of a head according to the invention in a partially assembled state.

[0010] Referring initially to Figure 1, the core of a magnetic head 10 comprises a pair of half-cores, right 11 and left 12, that are elongate in a direction defined here as longitudinal and facing one another in a transverse direction.

[0011] In the whole of the present description and in the claims which follow, terms and expressions indicating positions and orientations are intended to refer to the longitudinal direction of the head. Thus, the expression "forward side" indicates a side facing towards the sensitive part of the head.

[0012] The two half-cores have substantially C-shaped opposed cross-sections, with respective rearward edges 13, 14, in contact, and respective forward edges 15, 16 separated by a thin strip 17 of magnetically non-conductive material. The references 18, 19 indicate coils wound round the half-cores and electrically insulated therefrom by means of bodies of plastics material, as described in detail hereinafter.

[0013] The general arrangement of the head shown in Figure 1 is to be regarded as known as a whole. Consequently, in the continuation of the present description, only those elements of specific relevance and interest for the purposes of implementation of the invention will be described in detail. For the production of the parts and elements not illustrated in detail, reference may therefore be made to any magnetic head solution of known type.

[0014] According to the present invention, each half-core is composed of a plurality of modular half-core elements 20 longitudinally side by side with one another. As illustrated in Figure 2, each modular element 20 has a substantially C-shaped cross-section, with a rearward portion 21 extending in a transverse direction with a free end edge 13 intended to contact the free end edge 14 of an opposed identical modular element 20 forming part of the opposed half-core,

an intermediate portion 22, substantially perpendicular to the rearward portion 21, and a forward portion 23 having a part 24 protruding longitudinally from one side with respect to the intermediate portion 22.

[0015] The forward portion 23 is therefore asymmetric (Figure 3) with respect to a transverse plane which passes centrally through the rearward portion 21 and intermediate portion 22.

[0016] Figure 4 illustrates diagrammatically the arrangement assumed by the modular elements 20 in the head, once assembled. Due to the shape of the modular elements 20, when two of these elements 20a, 20b, each belonging to a different half-core, are opposed in such a way as to align transversely the rearward edges 13, 14 in contact with one another, the protruding part 24 of one of the two elements (20a) protrudes in the opposed longitudinal direction with respect to the protruding part 24 of the other element 20b. In other words, the forward portions 23 of the modular elements of a half-core 11 are longitudinally staggered, preferably by half a pitch, with respect to the forward portions 23 of the modular ele-

ments of the other half-core 12. Each pair of modular elements 20a, 20b transversely fitted side by side constitutes an open ring section of the core of the head.

[0017] As illustrated in Figures 7A and 7B, each modular element 20 is inserted and partially received in a support of plastics material 25 forming a tubular portion 26 (of rectangular section in the example illustrated) which contains within it the intermediate portion 22 and/or the rearward portion 21 of a modular element 20. One of the supports 25 is illustrated separately in Figures 5A and 5B. Round the tubular portion 26 is wound a coil 18 (or 19) the heads of which are electrically connected to connecting PINs 27 protruding from the rearward part of the head (Figures 6A, 6B and 7A, 7B).

[0018] In the preferred embodiment illustrated in the drawings, each support 25 is of modular type and has lateral connection means and seats 28 in the shape of small recesses and protuberances for being coupled mechanically to two like supports longitudinally adjacent on opposite sides and capable of supporting modular elements 20 belonging to the same half-core, and further front connection means and seats 30, 31, in the shape of small recesses and protuberances for mechanical coupling to a transversely adjacent support which supports a modular element 20 belonging to the other half-core. The forward part of each support 25 forms a horizontal plate portion 32 longitudinally staggered with respect to the main body of the support, such as to leave exposed a seat or recess 28 in which engages a small protuberance (not illustrated) projecting from the lower surface of the plate 32. The supports 25 further have a forward, vertical plate portion 29 forming a protuberance 30 and a recess 31 for mechanical coupling to the transversely opposed support of the other half-core. Preferably, the tubular portion 26 is inclined obliquely in a transverse plane and has two external flanges 26a for containing the coil.

[0019] The method for the assembly of the head according to the invention is as follows. After a coil has been wound round the tubular portion 26 of a support 25, a modular element 20 is inserted into the support, passing the element 20 through an opening 34 formed in the face of the support intended to face the centre line of the head. The angular joining portion between the intermediate portion 22 and rearward portion 21 remains inside the tubular portion 26 of the support. The free end edge 13 of the modular element protrudes transversely from the tubular portion of the support towards the centre line of the head, as illustrated in Figure 1. Since the forward portion 23 of the modular element 20 has a larger transverse dimension than that of the opening 34 of the support, the modular element remains suspended in a stable manner in the support in an intermediate stage of assembly (Figure 7A).

[0020] The same operations are performed, inserting a plurality of modular elements 20 into respective supports 25 provided with coils 18 (or 19). Then a certain number of supports 25 are mechanically coupled via the

lateral connection means/seats 28, obtaining a first half-core group of a length suitable for the head that is to be produced. The aforesaid operations are repeated in order to form a second half-core group of the same length as the first. The two half-core groups are then coupled transversely to one another, interposing between them a thin strip 17 of magnetically non-conductive material, which advantageously has a series of small openings 35 for allowing the insertion of the protuberances 30 into the recesses 31. Then the assembly formed by the two half-core groups with the strip 17 interposed, as shown in Figure 8, is placed in a screening container 36 of conventional type, and partially immersed in a bonding resin, as known to experts in the field, obtaining a single block which is then cut along the line L, allowing the opposite poles of the core and the gap to emerge. The PINs 27 are then connected to an electrical or electronic apparatus which receives and processes the electrical signals generated in the coils by the passage of a magnetized strip or thread which slides transversely on the head.

[0021] As may be observed, the present invention allows to produce in a modular manner magnetic heads of any desired length, solving the problems outlined in the introduction of the present description.

[0022] Owing to the configuration of the modular elements 20 (Figure 4), any transverse line T intersects the head in such a way as to remain contained between the opposed lateral edges of the forward portion of at least one (20a or 20b) of the elements of a pair of modular elements transversely side by side. Each modular element is magnetically coupled to the two modular elements longitudinally adjacent thereto in the same half-core. Therefore a strip of magnetized material (not illustrated) such as, for example, a security thread of a banknote, which passes transversely on the head along any transverse line T1-T4, always clearly intersects the forward portion of at least one modular element of one of the two half-core groups.

[0023] Whilst it is not desired to be bound to any specific theory in this regard, tests carried out by the Applicant show that, due to the staggered arrangement of the modular elements as described above, a clean electrical signal is always obtained at the PINs of the coils excited by the magnetic flux caused by a magnetized strip or thread which intersects the head at any point on its length. In particular, an easily scanned electrical signal is obtained even when the thread passes on the points of discontinuity at the edges of two adjacent modular elements, as indicated diagrammatically by the lines T3, T4 in Figure 4.

[0024] It is intended that the invention is not limited to the embodiment described and illustrated herein, which is to be regarded as an exemplary embodiment of the magnetic head. The invention is capable of modifications with regard to the shape and arrangement of parts, and constructional and functional details, as will be obvious to those skilled in the field.

Claims

1. A magnetic head for scanning magnetized strips or threads, of the type comprising a core of magnetic material in the shape of an open ring composed of two half-cores (11, 12), elongate in a longitudinal direction and having substantially C-shaped opposed cross-sections facing one another transversely, wherein each half-core (11, 12) has

- a rearward end edge (13, 14) capable of contacting a rearward end edge (14, 13) of the other half-core (12, 11) and

- a forward end edge (15, 16) parallel to, and magnetically separated from a forward end edge (16, 15) of the other half-core by means of a layer (17) of magnetically non-conductive material in such a way as to define a longitudinal gap which constitutes the sensitive part of the head;

characterized in that

each half-core (11, 12) is composed of a plurality of modular half-core elements (20) longitudinally side by side with one another and each having a forward portion (23) capable of defining a respective section of the forward end edge (15, 16) of one of the two half-cores (11, 12), and

the forward portions (23) of the modular half-core elements (20) belonging to one (11, 12) of the two half-cores are longitudinally staggered with respect to the forward portions (23) of the modular half-core elements (20) belonging to the other (12, 11) of the two half-cores.

2. A magnetic head according to claim 1, **characterized in that**

each modular half-core element (20) further forms a rearward portion (21) extending in a transverse direction with a rearward end edge (13, 14) capable of contacting a rearward end edge (14, 13) of an opposed modular element (20) forming part of the opposed half-core, and **in that**

said forward portion (23) comprises a part (24) protruding longitudinally from one side with respect to the rearward portion (21), so that in said assembled state

the rearward end edge (13) of each modular half-core element (20) is substantially aligned transversely and in contact with the rearward end edge (14) of a modular half-core element (20) belonging to the opposed half-core, and

the protruding part (24) of each modular half-core element (20) protrudes in an opposed longitudinal direction with respect to the protruding part (24) of a modular half-core element (20) belonging to the opposed half-core, so that the forward portions (23) of the modular half-core elements (20) belonging to one (11, 12) of the two half-cores are longitudinally stag-

gered with respect to the forward portions (23) of the modular half-core elements (20) belonging to the other (12, 11) of the two half-cores.

porting a modular half-core element (20) according to any one of the preceding claims from 1 to 5.

3. A magnetic head according to claim 1 or 2, **characterized in that** the forward portions (23) of the modular half-core elements (20) of one half-core (11) are longitudinally staggered by about half a pitch with respect to the forward portions (23) of the modular half-core elements (20) of the other half-core (12). 5
10
4. A magnetic head according to any one of claims 1, 2 or 3, **characterized in that** each modular half-core element (20) has a substantially C-shaped cross-section and is obtained by shearing and bending from a sheet of ferromagnetic metal. 15
5. A magnetic head according to any one of the preceding claims, **characterized in that** the forward portion (23) comprising the longitudinally or laterally protruding part (24) is asymmetric with respect to a transverse plane which passes centrally through the rearward portion (21). 20
6. A magnetic head according to any one of the preceding claims, **characterized in that** each modular half-core element (20) is partially received in an electrically insulating support (25) forming at least one substantially tubular portion (26) about which is wound a coil (18, 19) of electrical wire capable of linking a magnetic flux passing through the modular half-core element (20). 25
30
7. A magnetic head according to claim 6, **characterized in that** each modular half-core element (20) is partially received in a respective electrically insulating support (25) forming first lateral connection means (28) for mechanically coupling the support (25) to two like supports (25) longitudinally adjacent on opposite sides and capable of supporting modular half-core elements (20) belonging to the same half-core (11 or 12). 35
40
8. A magnetic head according to claim 6 or 7, **characterized in that** each modular half-core element (20) is partially received in a respective electrically insulating support (25) forming second front connection means (30, 31) for mechanically coupling the support (25) to a like support (25), transversely adjacent, which supports a modular half-core element (20) belonging to the opposed half-core. 45
50
9. A modular half-core element (20) according to any one of the preceding claims from 1 to 5. 55
10. An electrically insulating support (25) according to any one of the preceding claims from 6 to 8, for sup-

FIG. 1

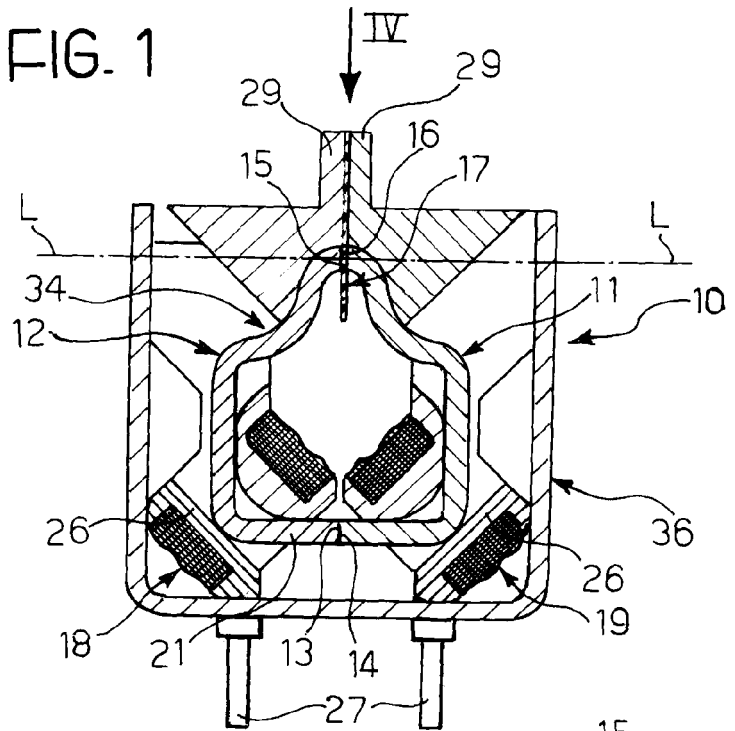


FIG. 2

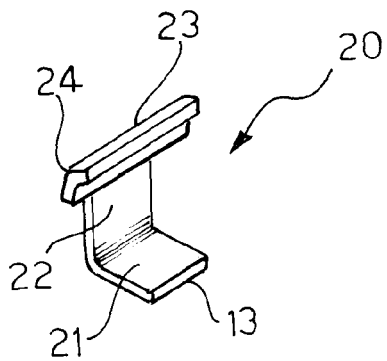


FIG. 3

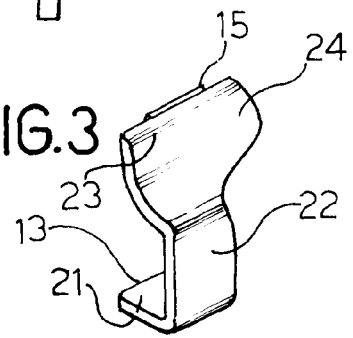


FIG. 4

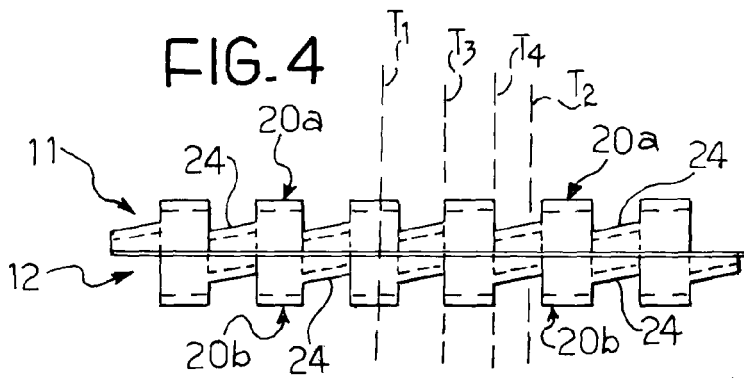


FIG. 8

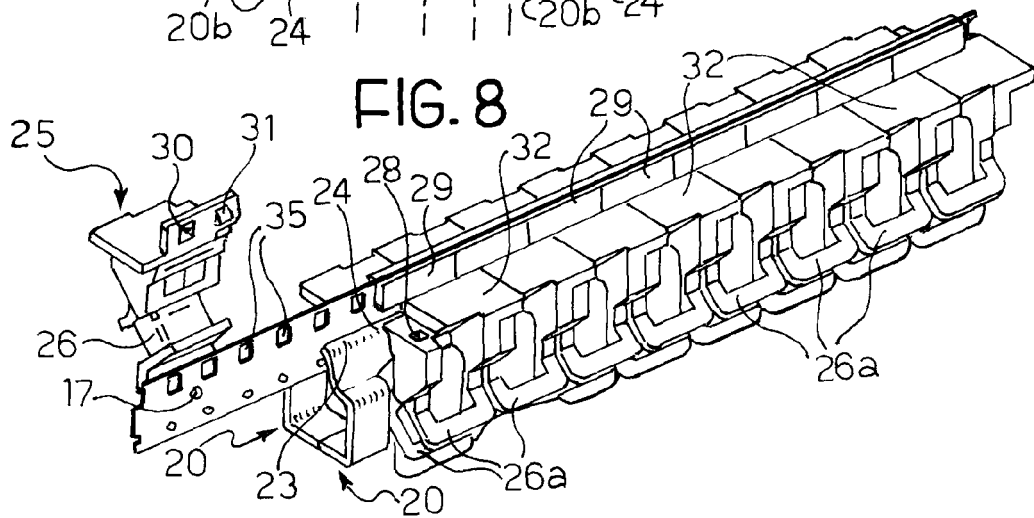


FIG. 5A

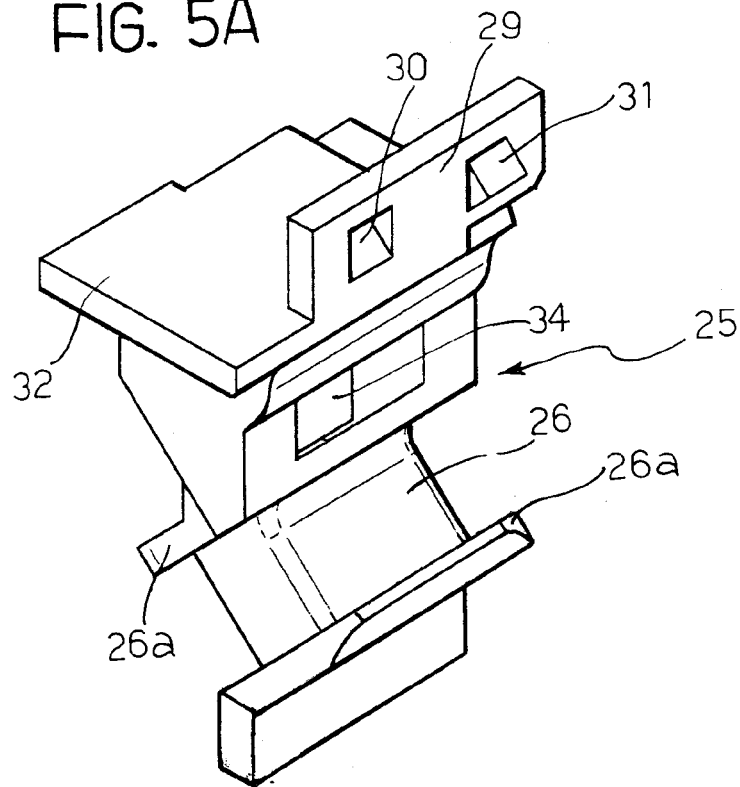
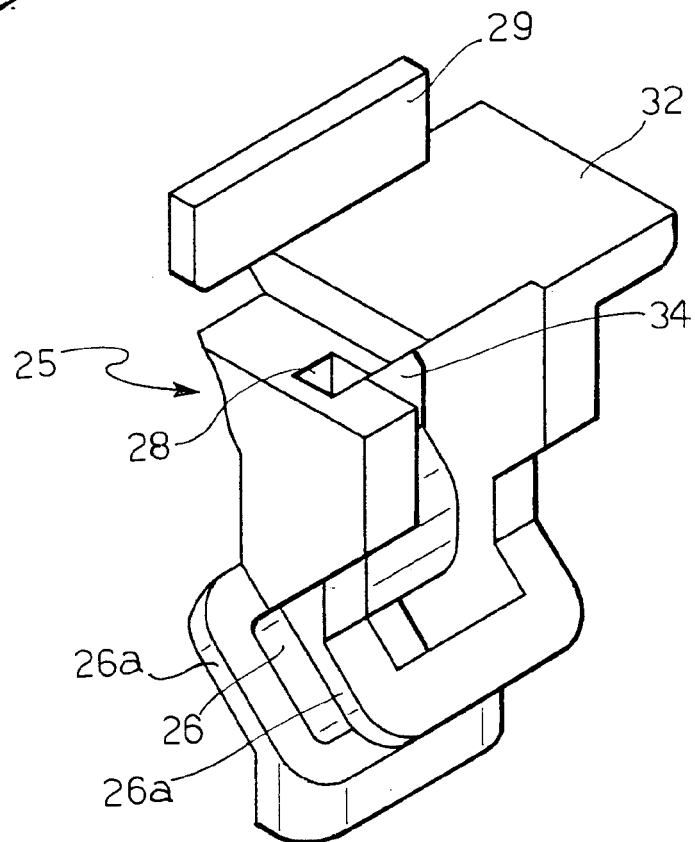


FIG. 5B



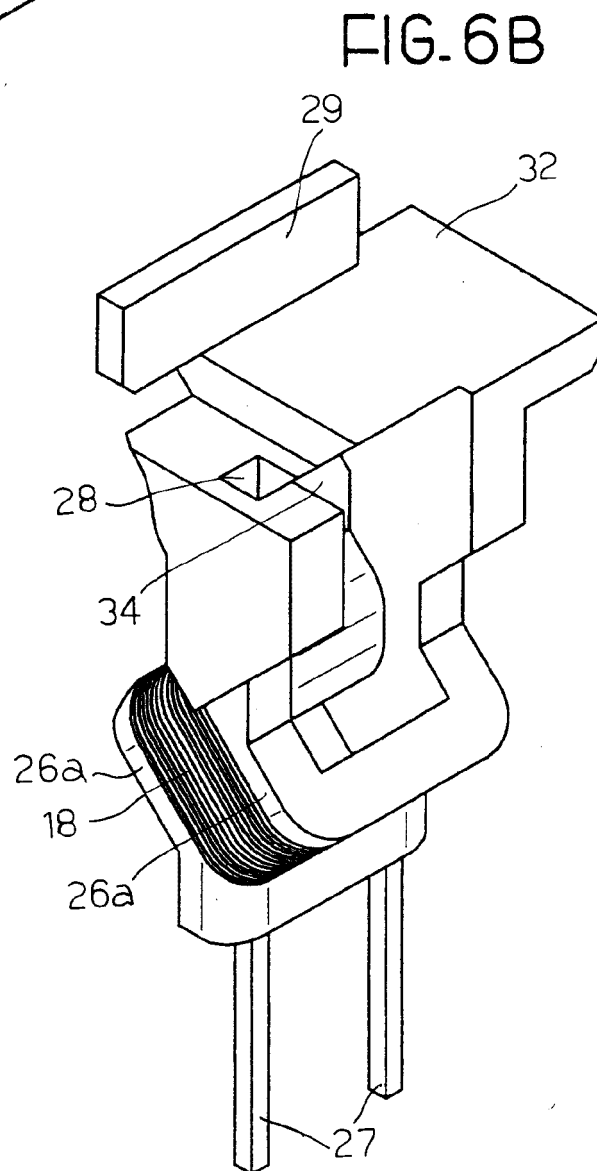
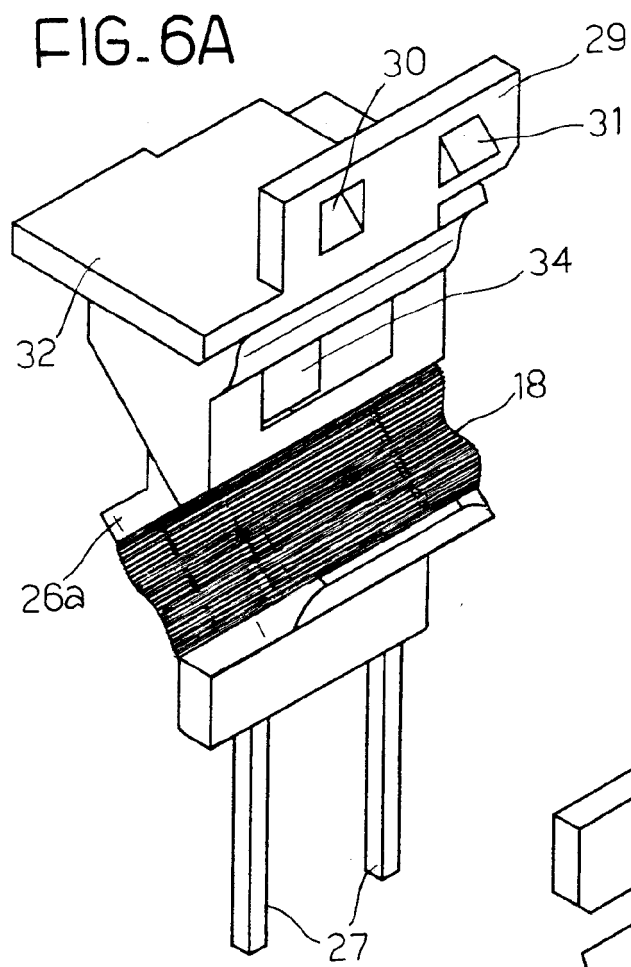


FIG. 7A

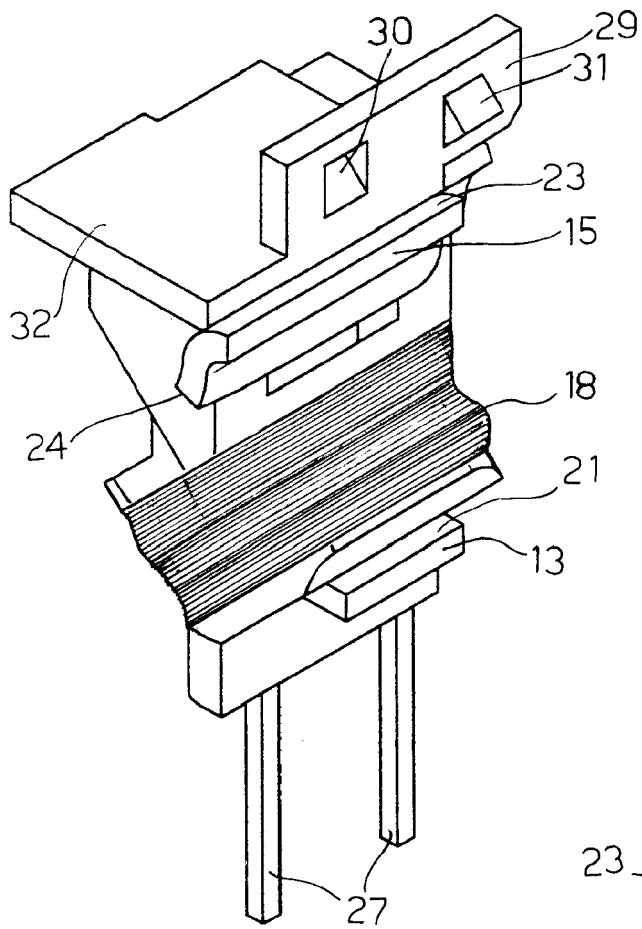


FIG. 7B

