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(54) **TEST STRIP DEVICE AND METHOD FOR ANALYZING A BODY FLUID**

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(57) **ABSTRACT**

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The invention concerns a test tape device for analyzing a body fluid having a carrier tape (36), a plurality of lancing elements (12) arranged on the carrier tape (36) which are provided with a tip (40) that can puncture a body part and a collecting structure (44) that takes up the body fluid obtained during the puncture, and test fields (14) mounted on the carrier tape (36) each being associated with a lancing element (12) and can have body fluid applied thereto. According to the invention it is proposed that the lancing elements (12) are each movably attached to the carrier tape (36) by a coupling member (38) and that a used lancing element (12) can be brought into contact with a test field (14) by a transfer movement from a usage position distant from a test field (14) into a contact position so that body fluid can be transferred from the collecting structure (44) onto the test field (14).

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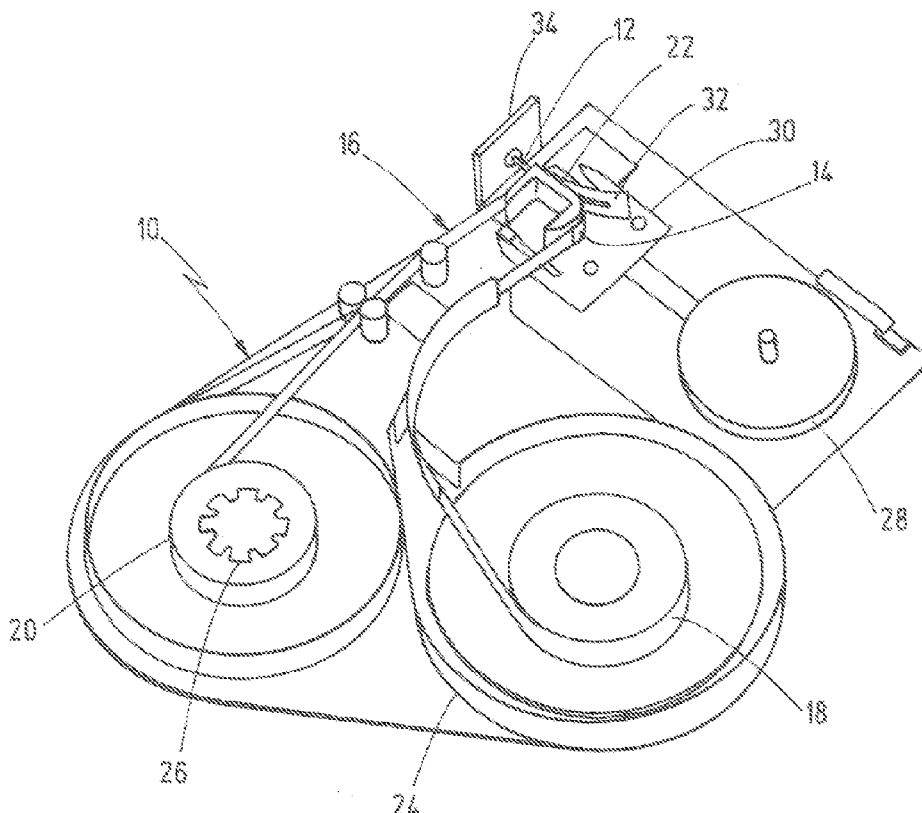
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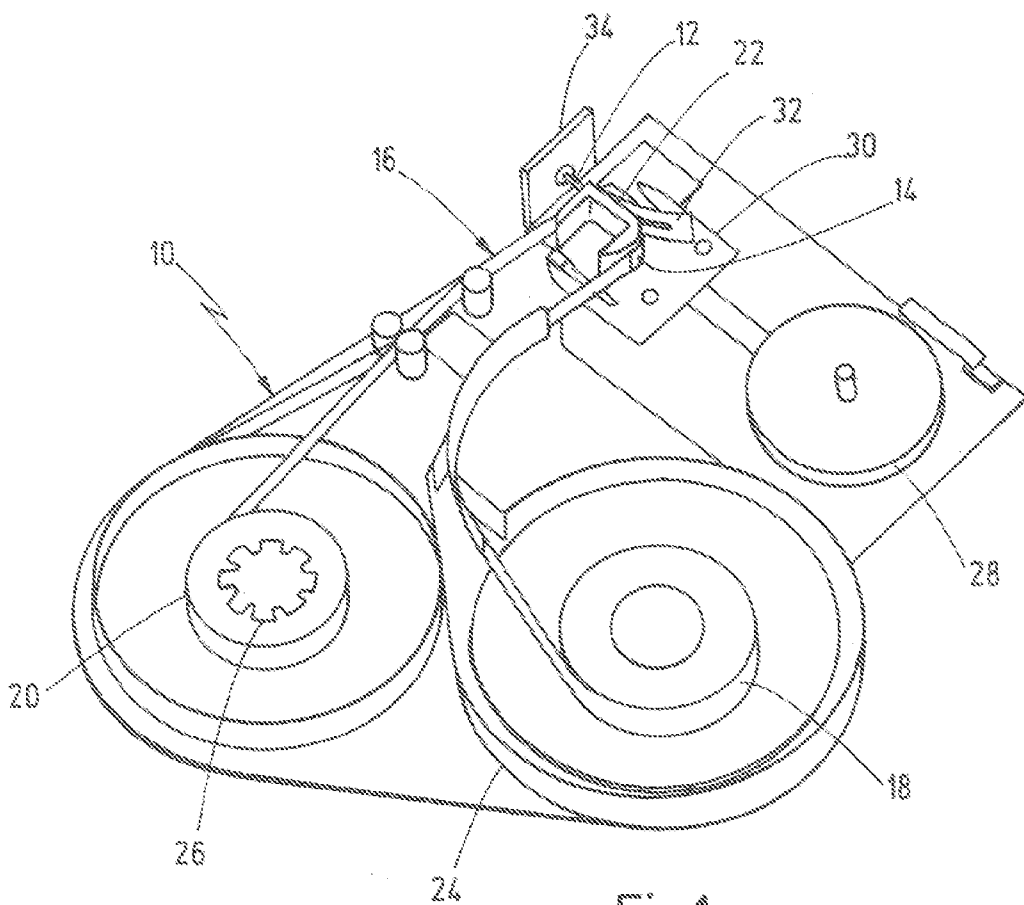


Fig.1

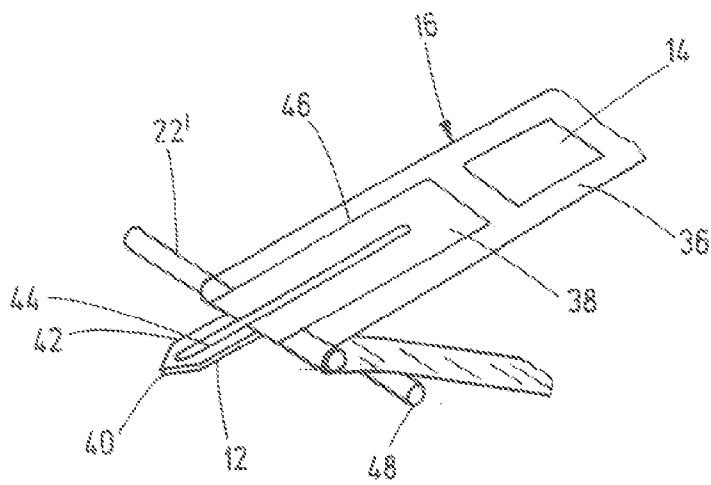
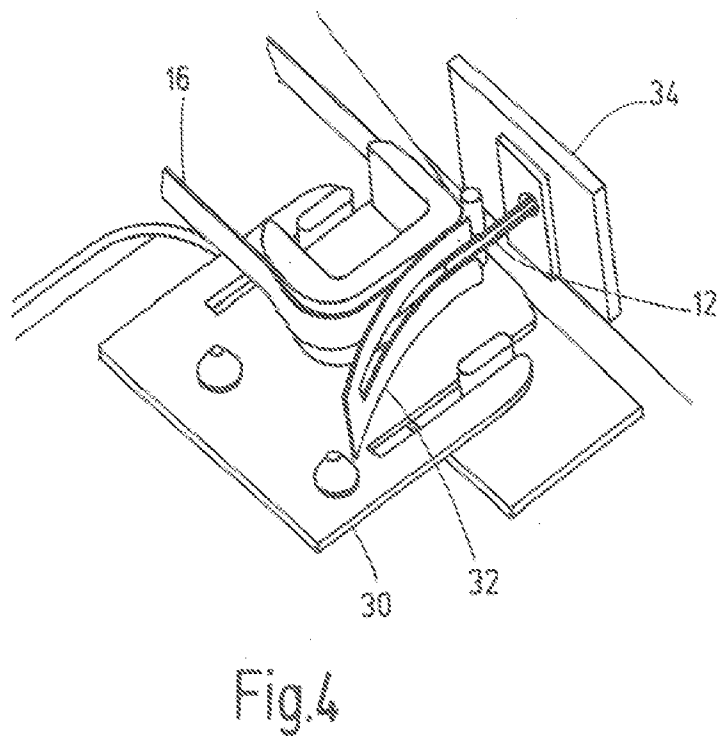
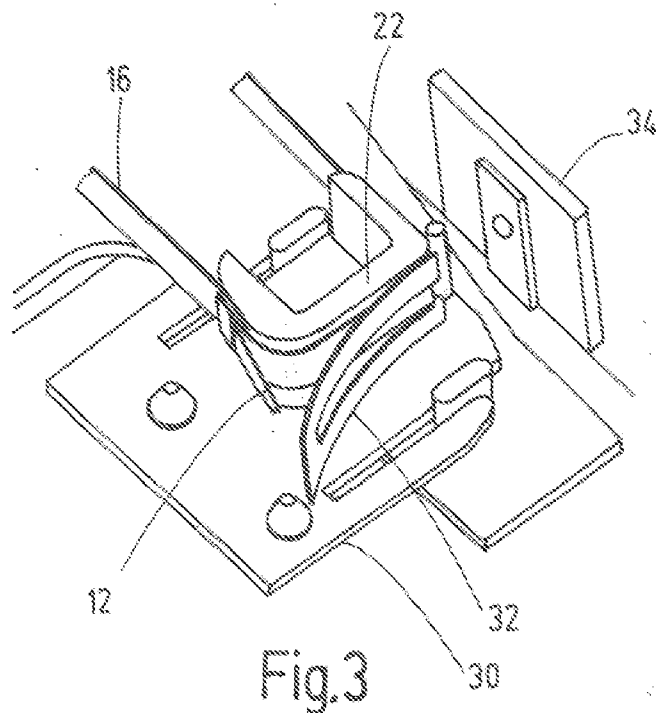


Fig.2



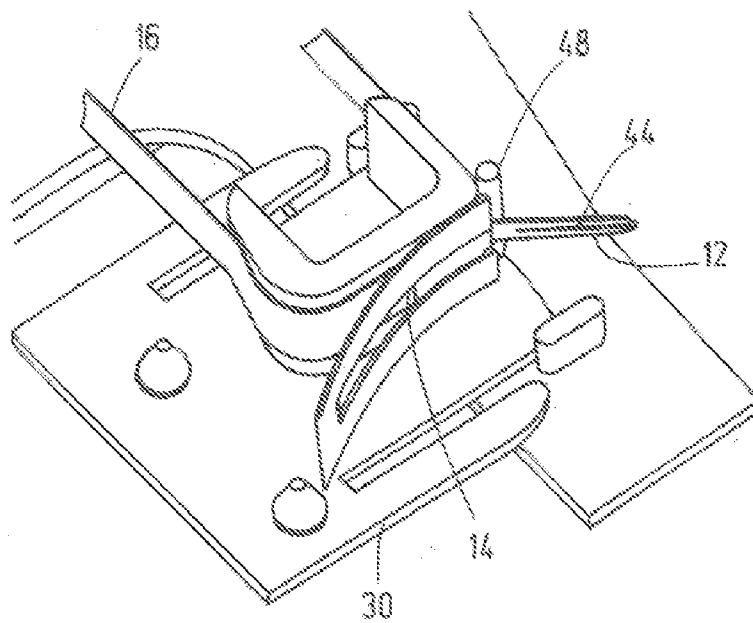


Fig. 5

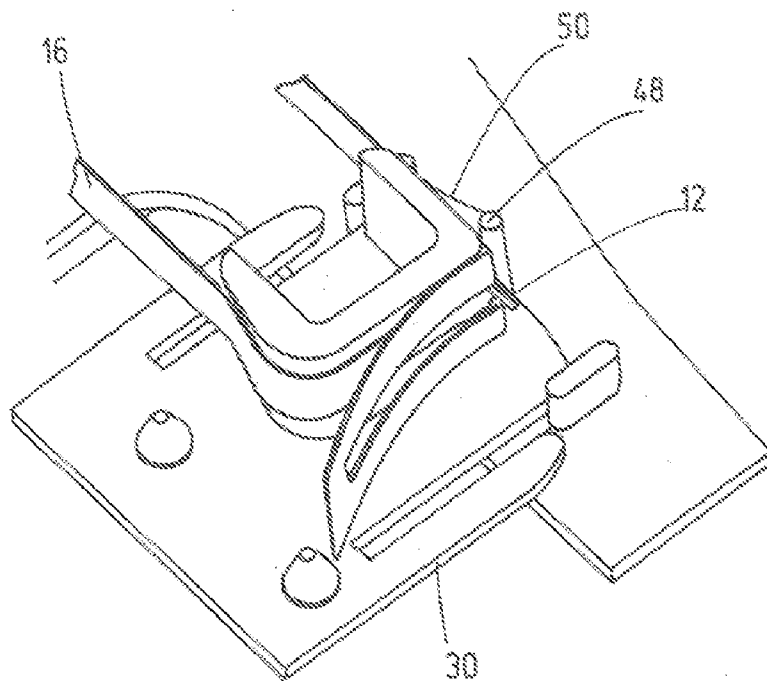


Fig. 6

### TEST STRIP DEVICE AND METHOD FOR ANALYZING A BODY FLUID

**[0001]** The invention concerns a test tape device for analyzing a body fluid especially for blood sugar tests having a carrier tape that can be wound onto or is wound onto a spool, a plurality of lancing elements arranged on the carrier tape which are provided with a tip that can puncture a body part and a collecting structure that takes up the body fluid obtained during the puncture, and test fields mounted on the carrier tape each being associated with a respective lancing element and can have body fluid applied thereto. The invention additionally concerns a corresponding method for analyzing a body fluid.

**[0002]** A test tape device of this type is known from WO2005/107596. A multilayer test tape is described therein in which a strip of tape carrying lancets is joined in a sandwich-like manner with a strip of tape provided with test fields. The test fields are in a fixed position in relation to a capillary groove of the lancets which delivers the body fluid by means of capillary transport. The tangential orientation of the lancets facing forwards in relation to the tape running direction is retained even during a tape deflection so that the lancet tips travel in a relatively large circular path until they have completely executed the change in direction of the tape. The sandwich arrangement also makes the overall structure relatively large. In addition embodiments are described in which the test fields are arranged alternately with the lancets and are spaced apart longitudinally on the tape in order that the user can actively apply a drop of blood after the puncture.

**[0003]** Starting from this the object of the invention is to further improve the products and methods known in the prior art and to design them such that a simplified handling without complicated actuating elements is possible in a compact arrangement.

**[0004]** The combination of features stated in the independent patent claims is proposed to achieve this object. Advantageous embodiments and further developments of the invention are derived from the dependent claims.

**[0005]** The invention is based on the idea of avoiding a long flow transport of the sample from the collecting structure onto the test field and instead to actively move the lancing element into a fluidic contact position. Accordingly it is proposed according to the invention that the lancing elements are each attached with limited movement capability to the carrier tape by a coupling member and that a used lancing element can be brought into contact or fluidic connection with a test field by a transfer movement from a usage position distant from a test field into a contact position that is executed by the lancing element itself so that body fluid is transferred directly from the collecting structure onto the test field. In this manner the lancing element can be kept very small and reduced to a lancing tip with a collecting volume. The time of sample transfer can be exactly determined by apparatusive measures. Additional handling by the user is not necessary for the sample transfer. At the same time the firm connection with the tape via the coupling member ensures that the lancing elements are stored in a correct position and can be simply disposed of. Moreover, sterilization is considerably simplified by the distance between the lancing element and sensitive detection chemistry on the test field in the initial state.

**[0006]** The orientation of the lancing elements relative to the tape can advantageously be reversed by the transfer move-

ment where the lancing elements can be oriented in the longitudinal direction of the carrier tape at least in the contact position and can be contacted with an associated test field by a pivoting movement and in particular a folding movement. However, it is also conceivable that the tips of the lancing elements point at right angles to the longitudinal tape direction.

**[0007]** Another advantageous embodiment provides that the lancing elements remain permanently connected to the tape by means of the coupling member during the transfer movement so that a complicated detachment is not required.

**[0008]** The lancing elements are particularly preferably hinged on the carrier tape in a proximal region spaced apart from the tip by means of a joint or hinge as a coupling member. This can be achieved in a simple manner by the lancing elements being pivotally connected to the carrier tape by means of a bending joint and in particular a film joint. A further improvement is achieved by means of the fact that the lancing elements are covered in a preferably sterile manner on the carrier tape by a foil or foil bag where the foil or foil bag is permanently connected to the carrier tape and to a proximal section of the respective lancing element.

**[0009]** The test fields advantageously have a reagent layer which is designed to detect an analyte in the body fluid.

**[0010]** Another particularly advantageous embodiment provides that the transfer movement of a lancing element can be triggered by advancing the carrier tape so that a complicated transfer mechanism is not necessary. This can be achieved in a simple manner in that the carrier tape is guided laterally past a retaining member and that the retaining member forms a stop obstacle for a lancing element which starts up during the tape transport preferably for folding down the lancing element. In this connection it is also preferable that the retaining member is located in the area of a deflection point for the carrier tape and the tip of the lancing elements can be lifted from the carrier tape at the deflection point.

**[0011]** In order to enable a defined lancing movement in connection with the tape that is also being moved, it is advantageous when the lancing elements are held in a gripping manner at a deflection point for the carrier tape by a holder or fastener in order to execute a lancing movement. Another improvement can be achieved in that the deflection point is arranged on a carriage that is also moved during the lancing movement.

**[0012]** In order to reliably ensure the liquid transfer, it is advantageous when the carrier tape is guided past a holding-down device which is formed in particular by a leaf spring, wherein the holding-down device presses a lancing element which passes through against a test field.

**[0013]** If a large number of self-tests have to be carried out on a regular basis, it is advantageous for the user when the carrier tape can be replaced as a single-use article preferably in the form of a tape cassette. Hence, the invention also concerns a test tape as a disposable for use in a test tape device according to the invention.

**[0014]** In order to solve the above-mentioned object, it is proposed with regard to the process that the lancing elements are each held in a movable manner on the carrier tape by a coupling member and that the lancing elements are brought into contact with a test field by a transfer movement from a usage position distant from a test field into a contact position so that body fluid is transferred from the collecting structure onto the test field.

[0015] The invention is further elucidated in the following on the basis of the embodiment examples shown schematically in the drawing.

[0016] FIG. 1 shows a test tape device in a diagrammatic view.

[0017] FIG. 2 shows a section of test tape with a lancing element that can be folded onto a test field in a perspective view.

[0018] FIGS. 3 to 6 show various functional positions of a lancing element on the test tape in a sectional enlargement of FIG. 1.

[0019] The test tape device 10 shown in the drawing enables a plurality of disposable lancing elements 12 and test elements 14 to be provided in the form of a test tape 16 for blood glucose determinations or other analyses on samples of body fluids in which the body fluid is transferred onto a test field by a movement of a lancing element relative to the test tape.

[0020] As shown in FIG. 1 the unused test tape 16 can be wound off a supply spool 18, whereas used tape material can be disposed of on a take-up spool 20. It is also conceivable that at least the supply spool is replaced by a chamber containing folded tape. The section of test tape that is in use is guided over a deflection point 22 and in this process is exposed for measuring purposes. The spools 18, 20 are preferably provided as consumables in the form of a tape cassette 24. In this manner a tape magazine is provided which allows a plurality of tests before the consumable has to be replaced.

[0021] In order to simplify blood glucose measurements as self-tests for a user, the device 10 is designed for a substantially automatic measuring process by means of a compact handheld device that is only shown diagrammatically. For this purpose a lancing drive 28 is also provided in addition to a tape drive 26 which engages with the take-up spool 20. The lancing drive 28 is connected with a carriage 30 for a linear movement and said carriage 30 carries the deflection point 22 and a gripper 32 for the lancing element 12. Thus, a lancing element 12 brought into an active position can pierce the skin of a finger or body part that is placed on a finger rest 34 through an opening in order to remove a small volume of blood for analytical purposes.

[0022] According to FIG. 2 the test tape 14 has a flexible carrier tape 36 on which the lancing elements 12 are each pivotally mounted via a coupling member 38 so that after sample uptake they can be brought into a contact position in fluidic connection with an associated test field 14 by means of a transfer movement from the shown usage position.

[0023] The lancing elements 12 stored on the carrier tape 36 have a sharp tip 40 at their distal end for puncturing the skin. The elongate shaft 42 which adjoins the tip is provided with a groove-shaped or slot-shaped capillary channel 44 for collecting the body fluid i.e. blood and/or tissue fluid that is obtained by the skin puncture.

[0024] In its initial position the lancing shaft 42 is aligned in the running direction of the carrier tape. In this alignment each of the lancing elements 12 is attached by a foil bag 46 formed by a glued-on strip of foil which ensures that they are covered in a sterile manner and at the same time forms the coupling element in the proximal area of the lancing element. For this purpose the rear area of the foil bag 46 is permanently joined to the shaft 42 and to the carrier tape 36. The flexible foil bag 46 thus acts as a film joint that can be bent around a bending line in a transverse tape direction in order to allow the lancing element 12 to be folded against the test field 14.

[0025] The folding down of the lancing element 12 serves as a transfer movement in order to enable a transfer of liquid onto a downstream test field 14 on the carrier tape 36 which is located in the pivoting area. The control of this movement solely on the basis of the tape advance can be simply understood on the basis of FIG. 2. Firstly the carrier tape 36 is deflected at such an acute angle on the deflection roller 22' that the tip 40 of a lancing element 12 running over the deflection roller pierces the foil bag 46 and is exposed for a skin puncture. During subsequent transport the exposed distal section of the lancing element 12 runs up against a retaining pin 48 which folds it around the coupling member 38 of the foil bag 46. In the folded down contact position the tip 40 points against the running direction of the tape while the capillary channel 44 is in fluidic contact with the test field 14 in order to transfer body fluid.

[0026] In order to detect an analyte in the body fluid, such as blood glucose, the test fields 14 are provided with a suitable reagent layer which reacts with a colour change during liquid uptake. This change in colour can be detected by a suitable optical detector that is not shown and displayed after measurement processing as a measurement result for the user.

[0027] The basic sequence of the process is shown in FIGS. 3 to 6 for the embodiment example according to FIG. 1 in some functional positions. FIG. 3 shows a situation corresponding to FIG. 2 in which the lancing element 12 is exposed by the deflection of the tape at the deflecting point 22. After a suitable tape advance the lancing element 12 is held in a gripping manner by the gripper 32 in order to execute a lancing movement through the finger rest 34 while the carriage 30 is pushed forwards (FIG. 4). In this process the deflected section of tape is moved together with the lancing element 12 in the puncture direction. Thus, the lancing element 12 can remain permanently connected to the carrier tape via the coupling member 38. Subsequently the folding movement of the lancing element 12 can be triggered by further tape transport according to FIG. 5 during which the retaining pin 48 located at the side of the tape acts as a stop obstacle. Finally according to FIG. 6 the contact position is reached in which the collected body fluid is transferred from the lancing element 12 onto the associated test field 14. This contact can be further intensified by a holding-down device that presses against the tape as it runs through which is for example in the form of a leaf spring 50.

[0028] Thus, neither a separate drive unit nor user handling is required for the targeted transfer of liquid. It is basically also possible to take up the body fluid by means of collecting elements which are not designed for a puncture but have a holding volume for liquid uptake.

1. Test tape device for analyzing a body fluid especially for blood sugar tests having a carrier tape (36) that can be wound onto or is wound onto a spool (18, 20), a plurality of lancing elements (12) arranged on the carrier tape (36) which are provided with a tip (40) that can puncture a body part and a collecting structure (44) that takes up the body fluid obtained by the puncture, and test fields (14) mounted on the carrier tape (36) each being associated with a lancing element (12) and can have body fluid applied thereto, characterized in that the lancing elements (12) are each movably attached to the carrier tape (36) by a coupling member (38), and that a used lancing element (12) can be brought into fluidic connection with a test field (14) by a transfer movement executed by the lancing element from a usage position distant from a test field

(14) into a contact position, so that body fluid is transferred directly from the collecting structure (44) onto the test field (14).

2. Test tape device according to claim 1, characterized in that the orientation of the lancing elements (12) relative to the carrier tape (36) can be reversed by the transfer movement.

3. Test tape device according to claim 1 or 2, characterized in that the elongate lancing elements (12) can be oriented in the longitudinal direction of the carrier tape (36) at least in the contact position.

4. Test tape device according to one of the claims 1 or 3, characterized in that the lancing elements (12) can be contacted with an associated test field (14) by a pivoting movement and in particular a folding movement.

5. Test tape device according to one of the claims 1 to 4, characterized in that the lancing elements (12) remain permanently connected to the tape by means of the coupling member (38) during the transfer movement.

6. Test tape device according to one of the claims 1 to 5, characterized in that the lancing elements (12) are hinged on the carrier tape (36) in a proximal region that is spaced apart from the tip (40) by means of a joint or hinge as a coupling member (38).

7. Test tape device according to one of the claims 1 to 6, characterized in that the lancing elements (12) are pivotally connected to the carrier tape (36) by means of a bending joint and in particular a film joint.

8. Test tape device according to one of the claims 1 to 7, characterized in that the lancing elements (12) are covered in a preferably sterile manner on the carrier tape (36) by a foil or foil bag (46) where the foil or foil bag is permanently connected to the carrier tape (36) and to a proximal section of the respective lancing element (12).

9. Test tape device according to one of the claims 1 to 8, characterized in that the test fields (14) have a reagent layer which is designed to detect an analyte in the body fluid.

10. Test tape device according to one of the claims 1 to 9, characterized in that the transfer movement of a lancing element (12) can be triggered by advancing the carrier tape (36).

11. Test tape device according to one of the claims 1 to 10, characterized in that the carrier tape (36) is guided laterally past a retaining member (48) and that the retaining member

(48) forms a stop obstacle for a lancing element (12) which starts up during the tape transport preferably for folding down the lancing element.

12. Test tape device according to one of the claims 1 to 11, characterized in that the retaining member (48) is located in the area of a deflection point (22) for the carrier tape (36) and the tip (40) of the lancing elements (12) can be lifted from the carrier tape (36) at the deflection point (22).

13. Test tape device according to one of the claims 1 to 12, characterized in that the lancing elements (12) are held at a deflection point (22) for the carrier tape (36) by a gripper (32) in order to execute a lancing movement.

14. Test tape device according to one of the claims 1 to 13, characterized in that the deflection point (22) is arranged on a carriage (30) that is also moved during the lancing movement.

15. Test tape device according to one of the claims 1 to 14, characterized in that the carrier tape (36) is guided past a holding-down device (50) which is formed in particular by a leaf spring, wherein the holding-down device (50) presses a lancing element (12) which passes through against a test field (14).

16. Test tape device according to one of the claims 1 to 15, characterized in that the carrier tape (36) can be replaced as a single-use article preferably in the form of a tape cassette (24).

17. Test tape (16) for insertion into a test tape device according to one of the previous claims preferably in the form of a replaceable tape cassette (24).

18. Method for analyzing a body fluid in particular for blood sugar tests in which a plurality of collecting elements (12) and associated test fields (14) are provided on a windable carrier tape (36) wherein the collecting elements (12) are provided with a collecting structure (44) which takes up a body fluid and body fluid from the collecting structure (44) is applied to the test fields in order to detect an analyte in the body fluid, characterized in that the lancing elements (12) are each held in a movable manner on the carrier tape (36) by means of a coupling member (38), and that the collecting elements (12) are brought into contact with a test field (14) by a transfer movement from a usage position that is distant from a test field (14) into a contact position so that body fluid is transferred from the collecting structure (44) onto the test field (14).

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