Analytical test tape instrument

Description

The invention concerns an analytical test tape instrument in particular as a hand-held device for blood sugar tests having an exchangeable test tape unit preferably in the form of a tape cassette which comprises a test tape provided with a plurality of test elements to which body fluid can be applied, and a tape drive that can be coupled with the test tape unit to wind on the test tape so that the test elements can be successively made available at an application site.

Such test tape systems have already been proposed in a number of patent applications from the applicant in order to gain further advantages for the user compared to the strip systems on the market. In addition to a reliable positioning of the test elements, it is also necessary for practical purposes to ensure that their on the spot use is not impaired by excessive noise development.

On this basis the object of the invention is to further improve the systems proposed in the prior art and to achieve a reliable test element positioning with little interfering noise in a compact assembly.

The combination of features stated in patent claim 1 is proposed to achieve this object. Advantageous embodiments and further developments of the invention are derived from the dependent claims.

The invention is based on the idea of using a compact high-speed motor. Accordingly it is proposed according to the invention that the tape drive has a direct current motor and a reduction gear unit arranged between the direct current motor and the test tape unit. The direct current motor can be readily integrated into a hand-

held device due to its small installation space and low energy requirement and it enables a low-noise and low-vibration operation while the reduction gear unit ensures a suitable rotational speed / torque conversion for reliable tape positioning. A simplified manufacturing process combined with a cost-effective construction method is another advantage.

The direct current motor is advantageously in the form of a mechanically commutated thin-profile rotor in order to achieve a uniform noise behaviour with little torque variation. Also such a motor can be simply constructed from a few parts and it is particularly suitable for battery operation. It would also be conceivable to use an electronically commutated direct current motor.

Another improvement with regard to interfering noises and contamination can be achieved by encapsulating the reduction gear unit preferably together with the direct current motor against the environment in a gear housing.

A particularly compact and precise assembly can be advantageously achieved in that the direct current motor has a motor housing sections of which are formed by a housing wall of the gear housing.

Another advantageous embodiment provides that the rotor of the direct current motor has a bearing located in the gear housing. This allows a further shortening of the tolerance chains in connection with the downstream gear unit. Another improvement in this regard arises as a result of the fact that the direct current motor has a bearing for its rotor located in a motor housing member and that the motor housing member is clamped in the gear housing. It is also advantageous when the gear member of the reduction gear unit which is directly coupled with the direct current motor is mounted in a housing section of the direct current motor.

In order to avoid acoustic bridges to the body, it is advantageous when the test tape unit can be put on an instrument chassis, wherein the gear housing is only connected at certain points to the instrument chassis while keeping an air gap clear.

In order to be able to reliably transmit the drive forces, it is advantageous when the reduction gear unit is in the form of a toothed-wheel gear unit and in particular a multistep spur gear unit with for example a laterally offset input and output. In this connection it is also advantageous for a cost-effective production when the gear wheels of the toothed-wheel gear unit consist of injection-moulded parts made of plastic, in particular POM.

In order to transport the test tape as uniformly as possible independently of the diameter of the spool it is advantageous when the tape drive has a speed controller to control the rotational speed of the direct current motor depending on the number of test elements of the test tape unit which have been provided. Another advantageous embodiment provides that the motor rotational speed of the direct current motor is in a range between 100 and 200 revolutions/s and that the output rotational speed of the reduction gear unit is between 0.2 and 0.5 revolutions/s.

The direct current motor is advantageously connected via brushes to a battery-powered energy supply, wherein brush holders are integrated in the gear housing to dampen brush vibrations.

Motor vibrations can be further minimized by means of the fact that the direct current motor has a motor shaft with a longitudinally slotted end section so that the slotted end section can be inserted into a bearing bore with tolerance compensation.

It is advantageous with regard to reduced bearing friction and correctness of the angle of motion transmission when the motor shaft of the direct current motor is

preferably configured as one piece together with a drive pinion made of plastic, in particular POM.

A major advantage of the tape drive according to the invention is, apart from noise reduction, also the compact design. Accordingly it is possible that a housing encasing the tape drive and accommodating the test tape unit encloses a constructed space of less than 150 cm^3, preferably about 135 cm^3.

Advantageously the tape drive is configured to rotate a take-up spool of the tape cassette to wind up the test tape provided with the test elements. Thereby, used test elements can be easily disposed.

The invention is further elucidated in the following on the basis of an embodiment example shown in the drawing.

Fig. 1 shows an analytical test tape instrument with an exchangeable tape cassette in a perspective view.

Fig. 2 shows the tape drive of the test tape instrument in an enlargement of a section of fig. 1.

Fig. 3 shows a profile of the tape drive along a line of intersection running through the axes of rotation of the gear wheels.

Fig. 4 shows the motor of the tape drive in an axial section.

Fig. 5 shows the motor shaft slotted at the end in a perspective sectional enlargement of fig. 4.

The test tape instrument shown in fig. 1 comprises an instrument unit 10 with a tape drive 12 designed to be particularly smooth running and an exchangeable tape cassette 14 which can be coupled with the tape drive. For the sake of clarity, the chassis of the instrument unit 10 is shown only with a section of the encasing housing 15. The test tape instrument can be used as a hand-held device for blood sugar measurements which can be carried out on the spot by the user himself. Details on this can for example be derived from EP-A 1 760 469 to which reference is herewith made in this connection.

The tape cassette 14 shown in fig. 1 from below in a rotated perspective contains a test tape 16 sections of which are provided with test fields 18 to the front side of which blood or body fluid can be applied in the area of a deflecting tip as an application site. At the same time the test field 18 can be measured at this site from the rear side by means of the measuring unit 19. For this purpose the test tape 16 is wound from a take-off spool 20 onto a take-up spool 22 so that the test fields 18 that are spaced apart from one another can be successively brought into use at the application site for successive tests. In this connection only the take-up spool 22 is driven by the drive pin 24 which engages in a form-locking manner.

As can also be seen in fig. 2 the tape drive 12 has an electric motor in the form of a direct current motor 26 and a downstream reduction gear unit 28. The reduction gear unit 28 is encapsulated and screened against the environment together with the motor 26 in a gear housing 30. In order to suppress structure-borne noise, the gear housing 30 is only connected to the underlying chassis 10 at a few attachment points while keeping an air gap free.

The gear housing is advantageously formed from an LCP (liquid crystal polymer) i.e. a high-melting material which allows narrow tolerances. Where appropriate other superstructures on the chassis 10 also consist of this material in order to ensure corresponding coefficients of linear expansion.

The reduction gear unit 28 consists of several gear wheels 34, 36, 38, 40 with rotary axes that are parallel to one another which as a multistep spur gear unit thus have a laterally offset input and output. Another gear wheel 42 on the underside of the chassis 10 is coaxially connected to the drive pin 24. The gear wheels as injection-moulded parts consist advantageously of POM (polyoxymethylene). With regard to further noise reduction it is advantageous when the depth of tooth of the first gear wheel 34 that engages with the rotor is increased so that the teeth are designed to be somewhat longer. As a result the teeth are less stiff and thus dampen vibrations.

In order to further limit an unintentional transmission of sound, the motor 26 is advantageously supplied with energy via vibration-cushioned brushes 44. For this purpose brush holders 45 of sufficient stiffness are integrated in the gear housing 30 in order to avoid high vibration frequencies. In addition parts of the brushes 44 can also be provided with grease in the area of the lower case 48 in order to dampen especially high frequency vibrations.

As can be seen in fig. 3, the gear housing 30 has an upper case 46 and a lower case 48 between which the gear wheels 36, 38 and 40 are mounted. In contrast the downwards projecting axis of the first gear wheel 34 which is directly coupled with the motor 26 is mounted in a housing member 50 of the motor housing 52 such that positioning tolerances are substantially minimized there. A further dome-shaped motor housing member 54 which forms the upper bearing for the motor rotor 56 is firmly clamped in an opening of the upper case 46 in order to ensure an exact centering and stabilization also at this position.

The motor housing 52 is not closed on all sides but rather its end face is open towards the bottom in order to create the most compact possible arrangement. The opening is covered by the lower case 48 which thus completes the motor housing and forms a bearing 58 for the rotor 56.

The upper case 46 is connected via point connections 60 with a control circuit board 62 which is only shown symbolically and has a rotational speed controller 64 for the motor 26. In this manner the rotational speed of the motor can be controlled in accordance with the spool diameter depending on the number of used tests in such a manner that a constant tape transport speed of about 15 mm/s is achieved. In this connection the motor speeds are in a range of about 100 to 200 revolutions per second whereby the required torque is also available due to the reduction to an output speed of the drive pin 24 of about 0.2 to 0.4 revolutions per second.

As shown best in fig. 4 the motor shaft 66 and a pinion 68 are formed from plastic, in particular POM, in one piece where the pinion meshes with the first gear wheel 34. The iron-free rotor results in a dwell momentum-free operation in addition to high dynamics. A mechanically commutated thin-profile rotor 70 is used for the rotor which, in addition to a small overall length, has a low starting voltage with a low energy consumption which is of particular advantage in a portable instrument for battery operation.

The lower bearing 58 of the rotor 56 is formed by a bore in the lower case 48. As shown in the detailed view of fig. 5, the motor shaft 66 can have an end section 70 that is longitudinally slotted and can be inserted by radial spreading with tolerance compensation into the bearing bore in order to ensure a particularly quite running. In this connection one should bear in mind that in this area vibrations of the motor shaft lead to a high noise emission whereas in the upper section of the shaft the gear wheel forces result in a preferred orientation in the bearing.

Especially the first gear wheel 34 which rotates at high speed is subjected to a radial force in a preferred orientation due to the meshing. In order to improve the bearing conditions in this connection, a hub with a prismatic guide for the gear shaft can be provided instead of a cylindrical bearing bore.

It is of major advantage to the user that the compact tape drive 12 also allows the instrument housing 15 to be very small. The enclosed instrument volume advantageously comprises about 135 cm^3 whereas an additionally coupled lancing aid (optional, not shown) has a constructional volume of about 20 cm^3 resulting in a total volume of about 155 to 160 cm^3.

Claims

1. Analytical test tape instrument, in particular for blood sugar tests having an exchangeable test tape unit (14) in the form of a tape cassette which comprises a test tape (16) provided with a plurality of test elements (18) to which body fluid can be applied, and a tape drive (12) that can be coupled with the test tape unit (14) to wind on the test tape (16) so that the test elements (18) can be successively made available at an application site, wherein the tape drive (12) has a direct current motor (26) and a reduction gear unit (28) arranged between the direct current motor (26) and the test tape unit (14), **characterized in that** the tape drive (12) has a speed controller (64) to control the rotational speed of the direct current motor (26) depending on the number of test elements of the test tape unit (14) which have been provided.

2. Test tape instrument according to claim 1, **characterized in that** the direct current motor (26) is in the form of a mechanically commutated thin-profile rotor.

3. Test tape instrument according to claim 1 or 2, **characterized in that** the reduction gear unit (28) preferably together with the direct current motor (26) is encapsulated against the environment in a gear housing (30).

4. Test tape instrument according to one of the claims 1 to 3, **characterized in that** the direct current motor (26) has a motor housing (52) sections of which are formed by a housing wall (48) of the gear housing (30).

5. Test tape instrument according to one of the claims 1 to 4, **characterized in that** the rotor (56) of the direct current motor (26) has a bearing (58) located in the gear housing (30).

6. Test tape instrument according to one of the claims 1 to 5, **characterized in that** the direct current motor (26) has a bearing for its rotor (56) located in a motor housing member (54) and that the motor housing member (54) is clamped in the gear housing (30).

7. Test tape instrument according to one of the claims 1 to 6, **characterized in that** the gear member (34) of the reduction gear unit (28) which can be directly coupled with the direct current motor (26) is mounted in a housing section (50) of the direct current motor (26).

8. Test tape instrument according to one of the claims 1 to 7, **characterized in that** the test tape unit (14) can be put on an instrument chassis (10) and that the gear housing (30) is only connected at certain points to the instrument chassis (10) while keeping an air gap clear.

9. Test tape instrument according to one of the claims 1 to 8, **characterized in that** the reduction gear unit (28) is in the form of a toothed-wheel gear unit and in particular a multistep spur gear unit with a laterally offset input and output.

10. Test tape instrument according to claim 9, **characterized in that** the gear wheels (34, 36, 38, 40) of the toothed-wheel gear unit (28) consist of injection-moulded parts made of plastic, in particular POM.

11. Test tape instrument according to one of the claims 1 to 10, **characterized in that** speed controller (64) controls the motor rotational speed corresponding to the number of used test elements such that the tape transport speed remains constant.

12. Test tape instrument according to one of the claims 1 to 11, **characterized in that** the motor rotational speed of the direct current motor (26) is in a range between 100 and 200 revolutions/s and that the output rotational speed of the reduction gear unit (28) is between 0.2 and 0.5 revolutions/s.

13. Test tape instrument according to one of the claims 1 to 12, **characterized in that** the direct current motor (26) is connected via brushes (44) to a battery-powered energy supply and that brush holders (45) are integrated in the gear housing (30) to dampen brush vibrations.

14. Test tape instrument according to one of the claims 1 to 13, **characterized in that** the direct current motor (26) has a motor shaft (66) with a longitudinally slotted end section (70) so that the slotted end section (70) can be inserted into a bearing bore with tolerance compensation.

15. Test tape instrument according to one of the claims 1 to 14, **characterized in that** the motor shaft (66) of the direct current motor (26) is preferably configured as one piece together with a drive pinion (68) made of plastic, in particular POM.

16. Test tape instrument according to one of the claims 1 to 5, **characterized in that** an encasing housing (15) encloses a constructed space of less than 150 cm^3, preferably about 135 cm^3.

17. Test tape instrument according to one of the claims 1 to 16, **characterized in that** the tape drive (12) is configured to rotate a take-up spool (22) to wind up the test tape (16) provided with the test elements (18).