According to a first aspect of the invention, a hand-held medical device is described, the hand-held medical device comprising a housing with a cassette compartment, an exchangeable test tape cassette received in the cassette compartment, and a drive assembly comprising an electric motor and a gear arrangement adapted for rotating a tape spool of the test tape cassette, wherein a test tape of the test tape cassette can be wound forwards and test elements thereon can be provided for successive use, wherein the gear arrangement has a worm drive in which a worm meshes with a worm wheel and a multistage speed-reducing unit comprising plurality of spur gears arranged between the worm wheel and an output gear directly coupled to the tape spool, wherein each of the plurality of spur gears has at least about 10 teeth, and wherein the worm is directly mounted on a motor shaft of the electric motor.

According to a second aspect of the invention, another hand-held medical device is described, the hand-held medical device comprising a housing with a cassette compartment; an exchangeable test tape cassette received in the cassette compartment, the test tape cassette comprising a test tape having test elements thereupon that can be provided for successive use and at least one tape spool connected to the test tape; and a drive assembly comprising an electric motor and a gear arrangement adapted for rotating the tape spool, wherein the gear arrangement has a worm drive in which a worm meshes with a worm wheel and a multistage speed-reducing unit comprising a plurality of spur gears arranged between the worm wheel and an output gear directly coupled to the tape spool, wherein the plurality of spur gears are arranged in a non-linear configuration so that centers of the spur gears span a polygon selected from the group consisting of a triangle and a quadrangle, and wherein a rotational axis of the electric motor is skewed or perpendicular to rotational axes of the plurality of spur gears.

The invention is based on the idea of using a worm drive and subsequent spur gears in order to reduce size and to control the rotational movement precisely. Accordingly it is proposed according to the invention that the gear arrangement has a worm drive in which a worm meshes with a worm wheel and a multistage speed-reducing unit downstream the worm drive and comprising several spur gears arranged between the worm wheel and an output gear that can be directly coupled to the tape spool.

Preferably, the worm is directly mounted on the motor shaft. This combination allows to considerably reducing size and operational noise while at the same time ensuring a sufficient turning moment for the rotation of the tape spool. Specifically, a high gear ratio can be performed in a small construction space, and the transmission can be kept non-reversible and with low backlash.

In a preferred embodiment the speed-reducing unit has at least two, preferably three meshing gear pairs for reducing the rotational speed between the worm drive and the output gear.

Another particularly advantageous embodiment provides that the speed reduction ratio between the rotational speed of the electric motor and the output gear is more than 300, preferably more than 400 and most preferably in the range between 400 and 500. Such a gear ratio has surprisingly been found to provide an optimum for several boundary conditions which are critical for the device design. Particularly, size reduction and elimination of noise as well as sufficient output torque in combination with a small-power DC motor are important for such a hand-held medical device.

In order to further avoid operational noise, it is advantageous when wherein each of the spur gears has at least 10, preferably at least 14 teeth.

Claims

1. Medical hand-held device, in particular blood glucose meter comprising

a) a housing (12) with a cassette compartment (14),

b) an exchangeable test tape cassette (16) received in the cassette compartment (14),

c) a drive assembly (18) comprising an electric motor (32) and a gear arrangement (40) adapted for rotating a tape spool (20) of the test tape cassette (16), such that a test tape (22) of the test tape cassette (16) can be wound forwards and test elements thereon can be provided for successive use,

d) wherein the gear arrangement (40) has a worm drive (52) in which a worm (56) meshes with a worm wheel (58) and a multistage speed-reducing unit (54) comprising several spur gears (60-66) arranged between the worm wheel (58) and an output gear (72) that can be directly coupled to the tape spool (20).

2. Medical device according to claim 1, wherein the speed-reducing unit (54) has at least two, preferably three meshing gear pairs (60,62';62'',64';64'',66) for reducing the rotational speed between the worm drive (52) and the output gear (72).

3. Medical device according to claim 1 or 2, wherein the speed reduction ratio between the rotational speed of the electric motor (32) and the output gear (72) is more than 300, preferably more than 400.

4. Medical device according to one of the claims 1 to 3, wherein each of the spur gears (60-66) has at least 10, preferably at least 14 teeth.

5. Medical device according to one of the claims 1 to 4, wherein the output gear (72) can provide a torque on the tape spool (20) of more than 20 mNm.

6. Medical device according to one of the claims 1 to 5, wherein the tape cassette (16) comprises a first tape spool (28) for unused tape, a second tape spool (20) for used tape and a seal (30) through which the test tape (22) is transported between the spools, where the output gear (72) is acting on the second spool (20).

7. Medical device according to one of the claims 1 to 6, wherein the worm drive (52) is self-locking such that the worm wheel (58) cannot drive the worm (56) when a torque is exerted on the tape spool (20).

8. Medical device according to one of the claims 1 to 7, wherein the self-locking force of the worm drive (52) is greater than 10 mNm and preferably greater than 14 mNm.

9. Medical device according to one of the claims 1 to 8, wherein the rotational axes (68) of the spur gears (60-66) are parallel to the rotational axis (74) of the tape spool (20).

10. Medical device according to one of the claims 1 to 9, wherein the rotational axis (50) of the electric motor (32) is skewed or perpendicular to the rotational axes (68) of the spur gears (60-66).

11. Medical device according to one of the claims 1 to 10, wherein the spur gears (60-66) comprise overlapping pairs of stepped wheels.

12. Medical device according to one of the claims 1 to 11, wherein the spur gears (60-66) are arranged in a non-linear configuration, such that the centres of the spur gears (60-66) span a polygon and in particular a triangle or quadrangle.

13. Medical device according to one of the claims 1 to 12, wherein the drive assembly (18) is mounted between a top-cover (44) and a bottom-cover (42) of a gearbox.

14. Medical device according to claim 13, wherein the axes (68) of the spur gears (60-66) extend from the bottom-cover (42) to the top-cover (44) of the gearbox and the shaft (50) of the electric motor (32) lies horizontally between the covers.

15. Medical device according to claim 13 or 14, wherein the top-cover (44) and bottom-cover (42) of the gearbox are detachably connected together preferably by means of screws (46).

Claims

1. A hand-held medical device comprising:
a housing with a cassette compartment, an exchangeable test tape cassette received in the cassette compartment, and a drive assembly comprising an electric motor and a gear arrangement adapted for rotating a tape spool of the test tape cassette, wherein a test tape of the test tape cassette can be wound forwards and test elements thereon can be provided for successive use, wherein the gear arrangement has a worm drive in which a worm meshes with a worm wheel and a multistage speed-reducing unit comprising plurality of spur gears arranged between the worm wheel and an output gear directly coupled to the tape spool, wherein each of the plurality of spur gears has at least about 10 teeth, and wherein the worm is directly mounted on a motor shaft of the electric motor.

2. A medical device according to claim 1, wherein the multistage speed-reducing unit has at least two meshing gear pairs for reducing the rotational speed between the worm drive and the output gear.

3. A medical device according to any one of the preceding claims, wherein of the output gear has about 60 teeth, and wherein the electric motor and the output gear have a speed reduction of at least about 300.

4. A medical device according to claim 1, wherein the output gear has about 60 teeth, and wherein of the electric motor and the output gear have a speed reduction ratio of at least about 400.

5. A medical device according to claim 3, wherein the output gear can provide a torque on the tape spool of at least about 20 mNm.

6. A medical device according to claim 1, wherein the test tape cassette further comprises a first tape spool for unused tape, a second tape spool for used tape, and a seal through which the test tape is transported between the first spool and the second spool, and where the output gear is acting on the second spool.

7. A medical device according to claim 1, wherein the worm drive is self-locking such that the worm wheel cannot drive the worm when a torque is exerted on the tape spool.

8. A medical device according to claim 7, wherein the torque exerted on the tape spool is at least about 10 mNm.

9. A medical device according to claim 7, wherein the torque exerted on the tape spool is at least about 14mNm.

10. A medical device according to claim 1, wherein rotational axes of the plurality of spur gears are parallel to a rotational axis of the tape spool.

11. A medical device according to claim 1, wherein a rotational axis of the electric motor is skewed or perpendicular to rotational axes of the plurality of spur gears.

12. A medical device according to claim 1, wherein the plurality of spur gears comprise overlapping pairs of stepped wheels.

13. A medical device according to claim 1, wherein the plurality of spur gears are arranged in a non-linear configuration, such that the centers of the spur gears span a polygon selected from the group consisting of a triangle or quadrangle.

14. A medical device according to claim 1, wherein the drive assembly is mounted between a top-cove and a bottom-cover of a gearbox.

15. A medical device according to claim 14, wherein axes of the plurality of spur gears extend from the bottom-cover to the top-cover of the gearbox, and wherein the shaft of the electric motor lies horizontally between the covers.

16. A medical device according to claim 14, wherein the top-cover and the bottom-cover of the gearbox are detachably connected.

17. A medical device according to claim 14, wherein the top-cover and bottom-cover are detachably connected by screws.

18. A medical device according to claim 1, wherein the worm wheel has 22 teeth and reduces motor speed by a ratio of 22:1.

19. A medical device according to claim 2, wherein the multistage speed-reducing unit has three meshing gear pairs.

20. A hand-held medical device comprising:
a housing with a cassette compartment; an exchangeable test tape cassette received in the cassette compartment, the test tape cassette comprising a test tape having test elements thereupon that can be provided for successive use and at least one tape spool connected to the test tape; and a drive assembly comprising an electric motor and a gear arrangement adapted for rotating the tape spool, wherein the gear arrangement has a worm drive in which a worm meshes with a worm wheel and a multistage speed-reducing unit comprising a plurality of spur gears arranged between the worm wheel and an output gear directly coupled to the tape spool, wherein the plurality of spur gears are arranged in a non-linear configuration so that centers of the spur gears span a polygon selected from the group consisting of a triangle and a quadrangle, and

wherein a rotational axis of the electric motor is skewed or perpendicular to rotational axes of the plurality of spur gears.

21. A medical device according to claim 20, wherein each of the plurality of spur gears has at least about 10 teeth, wherein the output gear has about 60 teeth, and wherein the worm is directly mounted on a motor shaft of the electric motor.

22. A medical device according to claim 20, wherein the worm wheel has 22 teeth and reduces motor speed by a ratio of 22:1.

23. A medical device according to claim 20, wherein the multistage speed-reducing unit has three meshing gear pairs.