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Van Riemsdijk

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[54] DRIVING MECHANISMS HAVING MULTIPLE MALTESE DRIVING GEAR

[75] Inventor: Gerardus Andriaan Van Riemsdijk, Nijmegen, Netherlands

[73] Assignee: Smit Nijmegen Electrotechnische Fabrieken, Nijmegen, Netherlands

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[51] Int. Cl. F16h 55/04

[58] Field of Search 74/436

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Primary Examiner—Leonard H. Gerin

Attorney, Agent, or Firm—Snyder, Brown and Ramik

[57] ABSTRACT

A multiple maltese driving mechanism for the conversion of the continuous rotation of a driving shaft into the stepwise movement of a body, said mechanism comprising a plurality of toothed members fixed to said body and a plurality of driving pins fixed to said driving shaft, said pins being adapted to cooperate in pairs with pairs of said members for special steps of said body and during such steps to drive said body by turns and to keep together said body positively coupled with said driving shaft.

2 Claims, 9 Drawing Figures

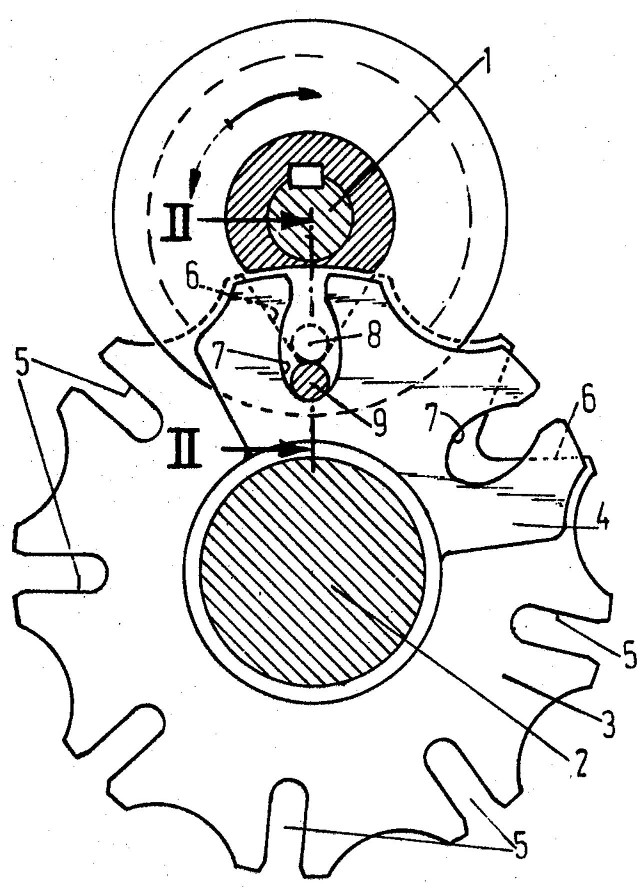
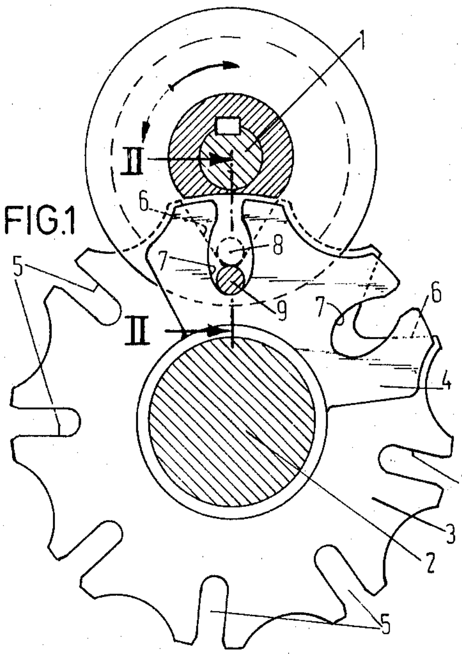


FIG.1



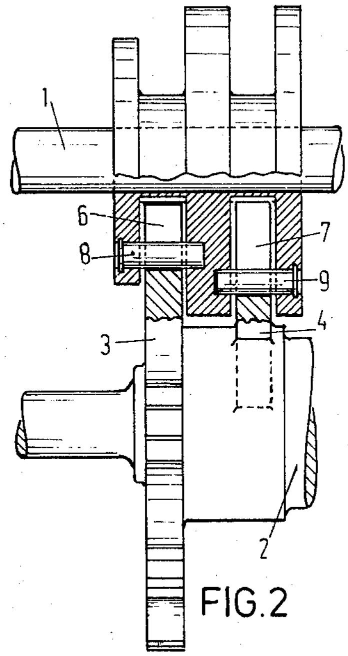
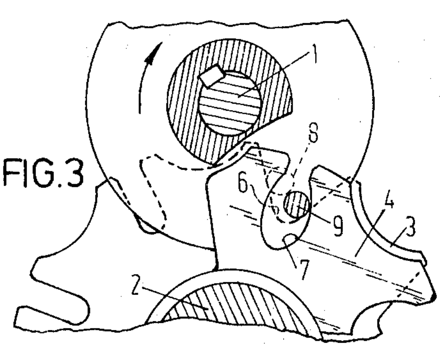


FIG.2

FIG.3



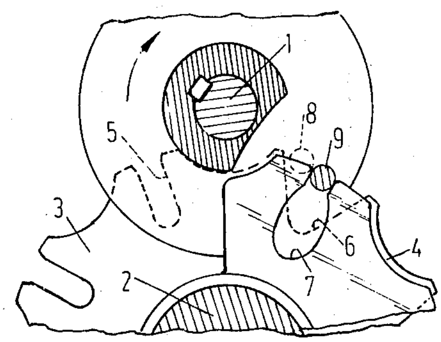


FIG.4

FIG.5

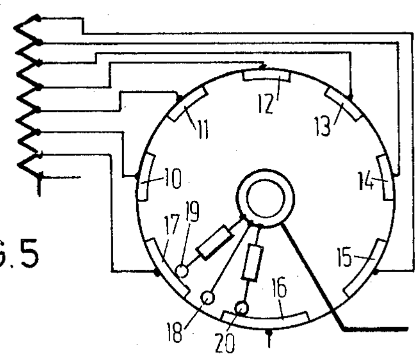


FIG. 6

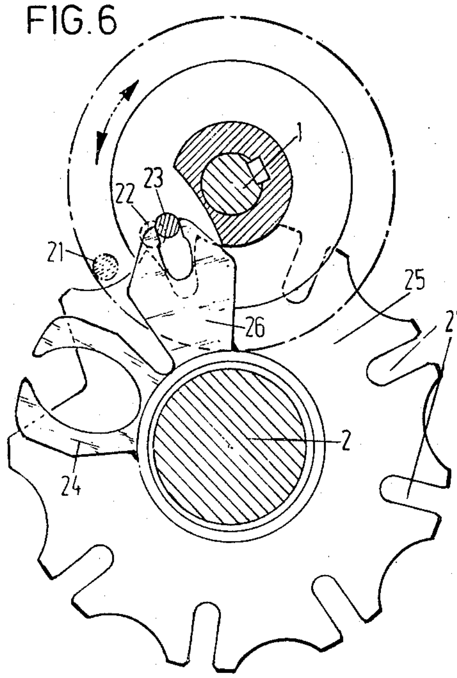


FIG. 7

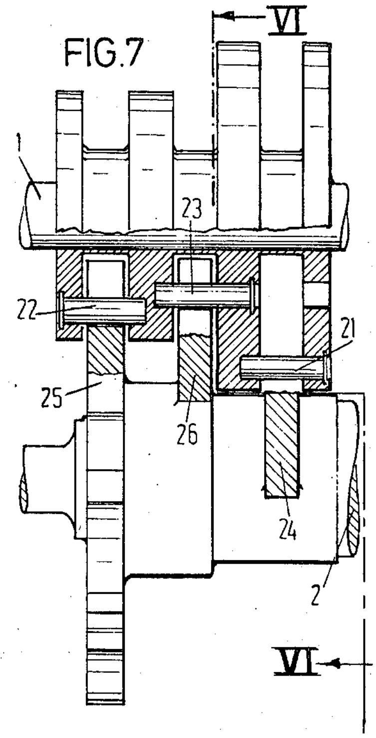
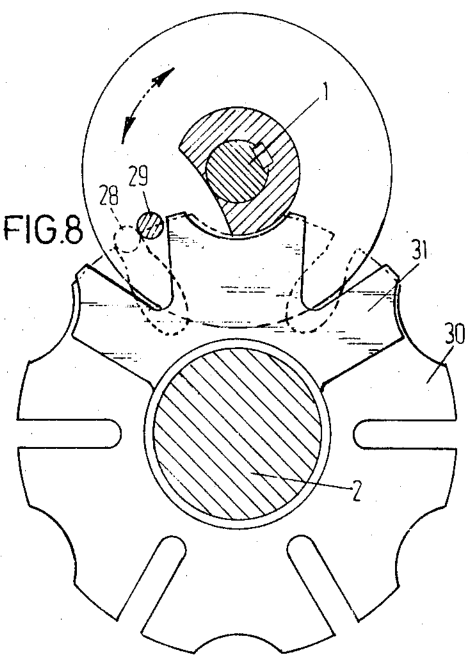


FIG. 8



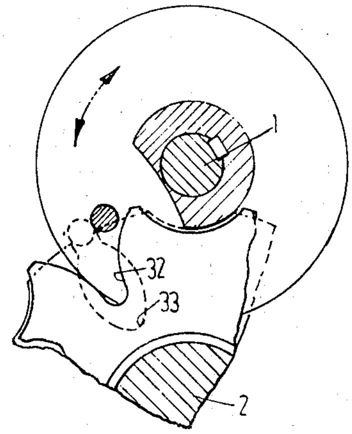


FIG. 9

DRIVING MECHANISMS HAVING MULTIPLE MALTESE DRIVING GEAR

The invention relates to a driving mechanism provided with a multiple maltese driving gear for the stepwise movement of a body, e.g. the stepwise rotation of a shaft, by means of a rotating driving shaft, in which the body to be driven comprises at least one pair of rigidly interconnected toothed members which are positioned side by side or one above the other in the direction of the driving shaft and extend transversely to said shaft, said toothed members overlapping each other at least partly in the direction of movement; in which the driving shaft is provided with at least one pair of driving pins, of which each one is adapted to cooperate with an individual one of said toothed members only, said driving pins being disposed at different radial distances from said driving shaft and extending parallel to said shaft in one and the same plane containing said shaft; in which each one of the overlapping portions of said toothed members has at least one tooth space and in which the tooth spaces of said overlapping portions form at least one pair of associated tooth spaces, of which the central lines lie in one and the same plane extending transversely to the direction of movement of the body.

A maltese driving mechanism of this kind for the stepwise rotation of a shaft, particularly the shaft of an on-load tap-changer for a regulating transformer, is disclosed in the Swiss Patent specification 434,450. This known maltese driving mechanism is used for the stepwise rotation of a tap selector over two different angles, said tap selector being adapted to operate under no-load contitions only. Therein the rotation over the larger angle is necessary in the region, where the voltage difference between two adjacent fixed contacts of the tap selector is a multiple of the voltage difference between the other adjacent fixed contacts. In this known driving mechanism the speed of switching during the rotation over the larger angle is greater than that during the rotation over the smaller angle. This difference of speed does not raise difficulties in a tap selector operating under no-load conditions, since no switching arc is produced during the change-over movement in such a tap selector. However it has appeared, that said difference of speed is disadvantageous in selector switches operating under load conditions, since therein the switching arc produced during the change-over operation over the larger angle, said arc disappearing at the zero transition of the current, that means at the most half a cycle after it has been started, is not extinguished until the movable contact, on which the switching arc is established, has almost reached the next fixed contact of the switch. Then the risc is great that the switching arc jumps to the next fixed contact and thereby produces a short-circuit.

The invention has the object to provide a driving mechanism with a multiple maltese driving gear, in which the mentioned disadvantage is avoided and by means of which a body can not only rectilinearly moved with different steps or rotated over different angles but also the curve of the speed of said body can be chosen at wil within a predetermined zone during its movement. Consequently, a driving mechanism according to the invention has more degrees of freedom than the known driving mechanism, whereby it is possible to make, for instance, the maximum speed during the greater step equal to that during a smaller step.

According to the invention this is achieved in that the tooth spaces formed in the overlapping portions of such a pair of toothed members and forming a pair of tooth spaces belonging to each other have such shapes that the driving pins engaging said tooth spaces during the stepwise movement of the body drive said body at least by turns and the body is, during said movement, positively coupled with the driving shaft by turns by one driving pin, and by the two driving pins together. Thus, in that case both driving pins act, during one movement of the body, on the toothed members of said body. If one driving pin is used for the greater step and the other one for the smaller step of the body, the speed of the body can during the movement thereof by both driving pins, be varied in the region lying between the region of speed depending on the action of one driving pin and the region of speed depending on the action of the other driving pin. The curve of the speed then depends on the shape of each one of the tooth shapes cooperating to effect the movement in question.

By a positive coupling between the body and the driving shaft is understood such a coupling, that in each angular position of the driving shaft only one single position of the body is possible.

In the mechanism constructed according to the invention said positive coupling is obtained, in that through a portion of the stroke one driving pin engages in the known way a fitting slot left between the teeth of one toothed member and through a next portion of the stroke one of both driving pins is used for driving and the other driving pin locks the position of the body relatively to that of the driving shaft. The driving pins may alternately have a driving and a locking function. How they cooperate depends on the shapes of the tooth spaces of the toothed members of said body.

The invention is not restricted to the use of one pair of toothed members and one pair of driving pins cooperating therewith. If, for instance, the driving shaft is provided with three driving pins lying at different radial distances from said shaft and the body is provided with three toothed members belonging thereto, three different pairs of driving pins and pairs of toothed members can be formed for moving the body with different steps and speeds, so that, when the driving pins can also be active by themselves only as in the known mechanisms, the body can be moved with steps of three different lengths and with six different curves of the speed. The driving mechanism constructed according to the invention and used for driving an on-load tap-changer for a regulating transformer may advantageously be so carried out, that of the tooth spaces formed in the overlapping portions of such a pair of toothed members and forming a pair of tooth spaces belonging to each other the tooth space of the toothed member cooperating with the driving pin which is closest to the driving shaft has a substantially triangular shape and the other tooth space has the shape of a bottle.

The invention will be further elucidated with the aid of the drawing. Therein are:

FIG. 1 partly a cross sectional view and partly a plan view of a maltese driving gear constructed in accordance with the invention,

FIG. 2 partly an axial sectional view on the line II—II and partly an elavational view of the driving mechanism shown in FIG. 1, FIGS. 3 and 4 different positions during a step of the driving mechanism shown in FIG. 1,

FIG. 5 a diagrammatical view of an on-load tap-changer, in which the driving mechanism illustrated in FIGS. 1–4 may be used,

FIG. 6 partly a cross sectional view and partly a plan view of a variant of the maltese driving mechanism shown in FIGS. 1–4,

FIG. 7 partly an axial sectional view and partly an elevational view of the driving mechanism shown in FIG. 6,

FIG. 8 partly a cross sectional view and partly a plan view of a second variant of the driving mechanism shown in FIGS. 1–4 and

FIG. 9 a detail of a third variant of the driving mechanism shown in FIGS. 1–4.

Although the drawing only shows maltese driving gear for the transmission of a continuous rotary movement into a stepwise rotation it will be obvious that such driving mechanisms can also be used for the transmission of a continuous rotary movement into a stepwise rectilinear movement. For the latter case a maltese toothed rack instead of a maltese toothed disc is used.

In FIGS. 1–4 a continuously rotating driving shaft is designated by **1** and a stepwise rotating driven shaft is indicated by **2**. Mounted on the driven shaft **2** are a toothed member in the shape of a disc **3** and, axially spaced therefrom, a toothed member in the shape of a sector **4**. The toothed disc **3** has eight tooth spaces, of which six consecutive tooth spaces **5** lie at equal smaller angular distances from each other and the two remaining tooth spaces **6** lie at greater angular distances from each other and from the tooth spaces **5**. The toothed sector **4** has two tooth spaces **7**, the centre line of each of which extends in the same plane containing the driven shaft **2** as the centre line of a tooth space **6** of the toothed disc **3**. A driving pin **8** cooperates with the toothed disc **3** and a driving pin **9** cooperates with the toothed sector **4**. The driving pins **8** and **9** extend parallel to the driving shaft **1** in one and the same plane containing said shaft **1**. The driving pin **8** lies closer to the driving shaft **1** than the pin **9**.

The shape of the tooth space **6** of the disc **3** is substantially triangular and the tooth space **7** has the shape of a bottle.

If the shaft **2** is rotated with its toothed sector **4** out of reach of the driving pin **9**, the stepwise rotation of the shaft **2** is determined only by the cooperation of the pin **8** and one of the tooth spaces **5** of the disc **3**. The shaft **2** is then rotated over the smaller angles. However, as soon as the toothed sector **4** has been brought into reach of the pins **9** and **8**, as is shown in FIG. **4**, the pin **9** engages the neck of the bottle-shaped tooth space **7** of the toothed sector **4**. The driving pin **8** penetrates at the same time into the V-shaped tooth space **6** of the disc **3**, but it remains yet clear from the left-hand tooth flank bounding the space **6**. The shaft **2** is then first driven by the pin **9** over a small angle. However, as soon as said pin has left the neck of the bottle-shaped tooth space **7** the driving pin **8** comes into contact with the mentioned tooth flank and the shaft **2** is driven, as is shown in FIG. **3**, through the disc **3** by the pin **8**. But the pin **9** comes into contact with the right-hand flank of the bottle-shaped tooth space **7** at the very moment, at which the pin **8** takes over the driving of the shaft **2** from the pin **9** (FIG. **3**). Owing thereto the shaft **2** is positively coupled with the shaft **1**, since, notwithstanding the V-shaped tooth space **6** and the bottle-shaped tooth space **7** are each too wide to lock the driving pin **8** and **9**, respectively, the two pins are active together and prevent that the shaft **2** with the toothed members **3** and **4** can have more than one angular position relatively to each active angular position of the driving pins **8** and **9**.

After the pin **9** has left the neck of the bottle the shaft **2** is driven by the driving pin **8** and the disc **3** only, till the centre position shown in FIG. **1** has been reached. This means that at passing said centre position the angular speed of the shaft **2** is equal to the maximum angular speed which occurs, when the driving pin **8** cooperates with one of the radial slots **5** of the disc **3**. However, as soon as the centre position shown in FIG. **1** has been passed, the pin **9** becomes the driving pin and the pin **8** sees together with the pin **9** to the positive coupling between the shaft **1** and **2**. Near the end of the stroke the pin **9** penetrates into the neck of the bottle again and the pin **8** leaves the driven flank of the tooth space **6** of the disc **3**, so that the shaft **2** is yet driven by the pin **9** only. Finally both pins leave the respective tooth spaces and the stepwise rotation has come to an end.

In the described multiple maltese driving gear the two driving pins **8, 9** act by turns as driving pin and the pin **9** sees to the positive coupling between the shafts **1** and **2**, as long as it is in the bottle neck during the first and the last part of the active stroke, whereas in the intermediate part of said stroke the pins **8** and **9** see together to said positive coupling. What will happen in the second half of the active stroke can be understood from FIGS. **3** and **4**, if the direction of rotation indicated by the arrow is reversed.

It will be apparent that, when the toothed disc **3** and the toothed sector **4** on one hand and the driving pins **8** and **9** on the other hand cooperate for the stepwise rotation of the shaft **2**, said shaft is rotated over a larger angle. Said angle is defined by the radial distance of the pin **9** from the driving shaft **1**. The other steps are smaller, as they are defined by the smaller distance between the pin **8** and the driving shaft **1**.

The driving mechanism shown in FIGS. 1–4 is adapted for a selector switch illustrated in FIG. **5**. This selector switch comprises eight fixed contacts which are arranged at equal free distances from each other. Of these fixed contacts the contacts **10, 11, 12, 13, 14** extend through equal smaller lengths of arc and the contacts **15** and **17** extend each through a somewhat greater length of arc, whereas the contact **16** has a length of arc which is still a bit greater. For the change-over operation of the integral group of rotatable contacts **18, 19, 20** from the fixed contact to the fixed contact **17** said group must be rotated over a larger angle than for the change-over operation between adjacent contacts of the series of fixed contacts **17, 10, 11, 12, 13, 14, 15**. It is a condition in this selector switch that, when the group of rotatable contacts **18, 19, 20** passes the intermediate position between two fixed contacts, the angular speed, that means the maximum angular speed, has always the same smaller value. This condition is satisfied by the driving mechanism shown in FIGS. 1–4, as during passing said intermediate position only pin **8** is active, so that then the angular speed is independent of the fact, whether the driven shaft **2** is driven one further step through a smaller or a larger angle.

In the variant illustrated in FIGS. 6 and 7 of the driving mechanism shown in FIGS. 1–4 the driving shaft is provided with three driving pins 21, 22 23 lying at different radial distances from said shaft in a common plane containing the driving shaft 1 and the driven shaft 2 comprises three toothed members 24, 25, 26 cooperating with said driving pins. In FIG. 6 the pin 23 starts to drive the shaft 2 through the toothed sector 26. Thereafter the pin 22 and the toothed disc 25 take over this driving action. During this driving action the stroke is defined by the pin 23 and the maximum angular speed is defined by the pin 22 only.

During the next revolution of the driving shaft 1 the driving pin 21 and 22, the sector 24 and the disc 25 come into action. The angular displacement of the shaft 2 is then determined by the pin 21 and the maximum angular speed by the pin 22. After the toothed sectors 26 and 24 have been active, the further rotation of the shaft 2 is carried out by the pin 22 and the disc 25 only. Therefor the rest of the disc 25 has in the normal manner radial slots 27.

In that case it is also possible to let the driving pins 21 and 23 cooperate, if to that and the shaft 2 is provided with a suitable toothed sector. Further more it is possible to reverse the actions to the cooperating driving pins when the tooth spaces are given suitable shapes to that end, so that the maximum angular speed is determined by the pin lying furthest from the driving shaft and the step is defined by the pin lying closest to said shaft.

In the variant shown in FIG. 8 all steps of the driven shaft 2 are equal, since the angular displacement is determined by the driving pin 28 lying furthest from the driving shaft 1. Only through two adjacent angles the shaft 2 is driven by the driving pins 28, 29, the toothed disc 30 and the toothed sector 31. During the movement through these angles the driving pin 29 sees to the reduction of the maximum angular speed.

Finally FIG. 9 shows a detail, in which the shapes of the cooperating tooth spaces differ from those of the driving mechanisms illustrated in the preceding figures. Therein the flanks of the triangular tooth spaces 32 are bent inwards and the shape of the bottle-shaped tooth space 33 is more cambering. It will be obvious that another shape of the flanks of a tooth space will correspond, during the step wise rotation or the stepwise rectilinear movement, with another curve of the speed. Furthermore it is observed that the two flanks of a tooth space need not be the mirror images of one another.

What I claim is:

1. A driving mechanism provided with a multiple maltese driving gear for the stepwise movement of a body, e.g. the stepwise rotation of a shaft, by means of a rotating driving shaft, said driving mechanism comprising at least one pair of toothed members which are rigidly connected to said body and extend in different planes at right angles with said driving shaft, said toothed members overlapping each other at least partly in the direction of movement of the body and at least one pair of driving pins rigidly connected to the driving shaft and extending parallel to and at different radial distances from the driving shaft in one and the same plane containing said shaft, each one of said driving pins being adapted to cooperate with an individual one of said toothed members only, each one of the overlapping portions of said pair of toothed members having at least one tooth space, of which the centre line lies in the same plane extending transversely to the direction of movement of the body as the centre line of an associated tooth space of the other toothed member of said pair and the two associated tooth spaces of the overlapping portions of said pair of toothed members having such shapes, that during its stepwise movement the body is driven at least by turns by the driving pins engaging said associated tooth spaces and is held positively coupled with the driving shaft by turns by one of said driving pins and by both driving pins together.

2. A driving mechanism as claimed in claim 1, in which of the two associated tooth spaces of the overlapping pinions of the pair of toothed members the one of the toothed member cooperating with the driving pin which is closest to the driving shaft has a substantially triangular shape and the other one has the shape of a bottle.

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