

SYSTEM FOR LIMITING ROTATING ANGLES

5 The invention relates to a system for limiting the rotating
angles of rotating component groups or processing units, with
a rotating drive consisting of an endless and positive-locking
power transmission element, preferably a toothed belt, trans-
mitting the rotary motion of a drive motor connected to a
drive pulley to the rotating component group, which is rigidly
10 connected to the drive pulley.

The limitation of the rotating angle of rotating component
groups is required in cases, in which the rotating component
groups must be supplied with energy of control signals via
15 connecting cables at the same time, or if measuring values
must be transmitted via cable to signal processing equipment.
This causes no difficulties at required rotating angles of up
to 360°, because the rotating motion is limited either by
means of limit stops or by the arrangement of actuating ele-
ments on the rotating component group, which act onto a fixed
20 limit switch in the area of the end of the rotating angle.

A solution of this kind is disclosed in DE 37 39 957.8, in
which an ultrasound contacting device with a rotating wire
25 bonding head is described, which is driven by means of a toot-
hed belt. The limitation of the rotating angle of the rota-
table bonding head is achieved in this case by means of a pin
on a toothed belt wheel arranged parallel to the axis of rota-
tion, which catches, in the area of the respective specified
30 limit stop, a rotating lever, which in turn, after executing
a swiveling motion in the direction of rotation, comes to rest
against a limit stop. Since the limitation of the rotating
motion must take place in both directions of rotation, the
limit stops are arranged outside the path of the motion of the
pin, so that it may pass the limit stop of the respective
35 opposite direction unobstructed in its return motion.

Such an arrangement has the serious disadvantage that the

contact with the hard limit stop may result in uncontrolled and disturbing vibrations, so that the overall function of the ultrasound wire bonder can be negatively affected.

5 If fixed tracing pins or proximity switching elements are used instead of hard limit stops, the problem is encountered that the tracing pins or proximity switching elements are actuated only briefly. This means that, while a processable switching
10 signal is available briefly at the predetermined position, it will be lost immediately at even the slightest amount of passing the end position or, for instance, a small opposite motion caused by vibrations. This results in considerable difficulties and inaccuracies, which may lead to damage of the rotating bonding head or the devices connected to it.

15 With the use of toothed belt gears for the drive of rotating processing devices with large rotating angles it is common practice to use nut-spindle drives with limit stops to set the maximum angle of rotation. For this purpose, the nut-spindle
20 drive must be coupled directly to the drive wheel of the toothed belt drive. Here, the nut moving on the spindle is used to actuate the limit switches. The maximum angle of rotation of the rotatable processing unit can be set by adjusting the axial position of the limit switches, since the stroke of the
25 nut-spindle drive between both of its end positions is proportional to the angle of rotation.

Such an arrangement requires a very elaborate design and thus is quite expensive to manufacture. Further to that, positioning
30 of the rotating processing unit can only be done indirectly in this way. The consequences are possible inaccuracies of positioning and elaborate set-up procedures. In addition, the basic set-up is very difficult and elaborate after changing the toothed belt.

35 Therefore, the objective of the invention is the creation of a system for limiting the rotation angles of rotating component groups or processing units which can be realized with

simple means, while having a high degree of operating and switching reliability.

5 According to the invention, the solution is characterized by the provision of at least one switching element secured to and rotating synchronously with the driven pulley, or connected to the latter, the switching element can be actuated in a predetermined rotation angle position by actuator elements connected to the force transmission element and capable of moving
10 with the latter, whereby the switching element remains actuated when the predetermined rotation angle position is passed and stops the drive motor.

15 Such an arrangement in accordance with the invention can be realized with simple means and, beyond that, assures a high degree of operational reliability, since reaching the desired rotation angle can be determined directly on the rotating processing unit. Thus, additional measuring devices, which may lead to uncertainties and inaccuracies, are not required.
20 Further to that, the limitation of rotating angles is achieved without fixed limit stops, so that braking of the processing unit takes place smoothly and without vibrations, when the drive motor is switched off or reversed upon reaching the predetermined rotation angle.

25 The cams of the toothed belt are preferably used as actuating elements. In this case, in order to achieve a clear coordination between the predetermined position of the rotation angle and the actuated switching element, it is useful to relieve
30 the toothed belt in the position of the switching element within the permissible rotation range of the drive pulley, by removing the cam which actually actuates the switching element.

35 In one variation of the invention the actuating elements are designed as auxiliary cams connected to the toothed belt, while these are preferable connected to the toothed belt in detachable fashion.

The preferred design of the switching element is a mechanically actuated tracing pin, which is radially embedded in the drive pulley, interrupting the toothed belt. Such an arrangement assures a high degree of operational reliability and, in addition, requires low maintenance.

The tracing pins are arranged on the drive pulley in such a way, that they are actuated in the predetermined position of the rotation angle, when the toothed belt meets the drive pulley tangentially.

In another variation of the invention, the switching element may also be actuated optically or electromagnetically. For this purpose, reflex light barriers or electromagnetically operated Reed contacts, for instance, are suitable devices.

The distance between two actuating elements on the toothed belt corresponds to the distance which a fixed point on the drive pulley travels with the rotation by a predetermined angle value. The limitable rotation angle is thus limited only by the length of the toothed belt. In this way it becomes apparent, that this inventions makes it possible without any problem to predetermine rotation angles above 360° for rotating processing units. Principally, integral multiples of 360° , plus the angle between the tangents with which the toothed belt meets the drive pulley, can be realized.

A particularly high degree of operational reliability can be reached by means of a design, in which the tracing pins and associated actuating elements, which are fixed to each other in place, continue to move further when passing the predetermined rotation angle. This means, that the switching signal of the respective tracing pin continues to be effective even after the processing unit travels beyond maximum rotation angle, which may be the case due to the moment of inertia. Another advantage of this arrangement may be seen in the fact, that the direction of the reverse motion is clearly defined.

In another version of the invention the drive pulley is equipped with an indicator to determine the zero position. This makes the assembly or exchange of the toothed belt considerably easier.

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In a further development of the invention, one drive pulley or the other drive pulley is equipped with a brake actuated by a tracing pin. Thus, the possibility is created for a quick and defined braking of the processing unit upon reaching the maximum rotation angle.

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In the following, the invention is explained in more detail by means of an application example and associated drawing:

15 The drawing shows a toothed belt drive, in which a drive pulley 2, mounted on the shaft of a drive motor 1 is connected by means of a toothed belt 3 to a drive pulley 4, which is able to rotate in a holder 5 of a bonding unit not shown. The drive pulley 2 and the drive pulley 4 are equipped along their circumference with gear teeth 6, having a pitch corresponding to
20 toothed belt 3. For the limitation of the rotation angle of drive pulley 4 in one direction of rotation, a tracing pin 7 is embedded in it, interrupting the gear teeth 6. The tracing pin 7 is embedded in the circumference of the drive pulley 4
25 in such a way, that its switching element does not protrude beyond the gear teeth 6, so that this is not actuated by the teeth of the drive belt 3.

30 The actuation of the tracing pin 7, which follows the motion of the drive pulley 4, takes place with the aid of an auxiliary cam 8 which is mounted on the toothed belt 3 in such a way, that it protrudes in the direction of the gear teeth of the drive pulley 4 from the gear teeth of toothed belt 3. Preferably, the auxiliary cam 8 is arranged in place of a tooth of
35 toothed belt 3. The attachment of the actuating element 8 can take place by means of a screwed connection, rivet, or similar item.

With this arrangement, the limitation of the rotation angle of a rotating processing unit is possible in one direction, while some particular advantages can already be seen. These can be seen in the fact, that the braking upon reaching the end of the rotating angle, respectively the operation of tracing pin 7, can take place smoothly, since fixed limit stops are no longer required. Braking can take place by means of switching off or reversing the drive motor 1, when the tracing pin 7 is operated. The consequence is that vibrations are completely avoided, which otherwise would be caused by abrupt stopping of the rotation motion. Of course, with sufficient length of the toothed belt 4, it is also possible to limit the angle of rotation in both directions.

In a special variation of the invention, it is possible to limit the rotation angle without auxiliary cams 8 on the toothed belt 3. In this case, the cams of toothed belt 3 are used to actuate tracing pin 7. This variation provides the particular advantage of eliminating any weakening by the screw attachment of the auxiliary cam 8. Further to that, the otherwise required groove in the gear teeth of drive pulley 2 can be omitted.

Since the tracer pin 7 has multiple contacts with a cam of the toothed belt 3 during one revolution of the toothed belt 3, tracer pin 7 would be actuated very time, which is undesirable. For this reason it is necessary to leave out the corresponding cams which would come into contact with the tracer pin 7 in the permissible rotating range of the drive pulley. Since the number and size of the cams has no influence on the tensile strength of the toothed belt 3, no weakening of the toothed belt occurs when one or more cams are removed. This also achieves a clear allocation of the drive pulley 4, respectively tracer pin 7 to toothed belt 3 and thus a clear limitation of the rotation angle, such as is the case with the use of auxiliary cams 8.

Further to that, there is a further possibility to equip the

drive pulley 4 or the drive pulley 2 with an auxiliary brake, which is also actuated by the tracer pin 7.

5 With the above described device the limitation of the rotation angle to a predetermined value above 360° can be achieved in a particularly simple way, as is useful, for instance, for ultrasound wire bonders with a rotatable bonding head. In this way the wire straps between the bond pads on semiconductor elements and external contacts can be manufactured in any
10 desired direction and in the shortest possible time.

Owing to the invention it is now possible to limit any desired rotation angle, while multiple rotations, or portions thereof, may also be realized, as explained in the following. The pre-
15 condition for this is a sufficient length of the toothed belt 3. Principally, integral multiples of 360° plus the angle between the tangents, with which the toothed belt 3 meets the drive pulley 4, can be realized.

20 All that is required for this purpose is to equip the drive pulley 4 with two tracer pins 7, 7', which must be arranged in such a way, that they are actuated when the toothed belt 3 meets the predetermined rotation angle position tangentially with its auxiliary cams 8, 8'. The actuation of the tracer
25 pins 7, 7' can then take place with the auxiliary cams 8, 8', which are attached to the toothed belt 3. The distance between the auxiliary cams 8, 8' must correspond to the distance which a fixed point on the drive pulley travels in the rotating motion by the predetermined angle value. This angle value may
30 be any desired value, depending on the actual requirements.

Owing to the fact that the tracer pins 7, 7' continue to move together upon reaching and passing the respective predetermined rotation angle, a particularly high degree of operational
35 reliability is achieved. The switching signal of the respective tracer pins 7, 7' remains available even after the processing unit, respectively the rotating bonding unit should move past the maximum rotation angle. Thus, a renewed activation of

the drive motor 1 after possible overshooting the predetermined rotation angle is prevented, respectively only one direction of rotation is permitted, namely the direction not excluded by reaching the limit switch.

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An identical function is achieved, if the auxiliary cams 8, 8' are omitted on the toothed belt 3 and instead the cams of the toothed belt 3 are removed, which should not actuate the tracer pins 7, 7'.

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The above described way of limiting the rotation angle of rotating component groups represents one of the possible designs of the invention. However, it is also possible to realize the limitation of rotation angles with various combinations of tracer pins 7 on the drive pulley 4 and associated auxiliary cams 8, 8' on the toothed belt 3 or by the omission of cams on the toothed belt 3.

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In order to guarantee a clear and permanent allocation of the auxiliary cams 8, 8' to the tracer pins 7, 7', any kind of relative motion between the drive pulley 4 and the power transmission element must be positively prevented. For that reason, a toothed belt is best suited, while the use of a chain is also possible.

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Further to that, there is an indicator 9 provided on drive pulley 4, which is embedded in similar fashion to the tracer pins 7, 7'. With the aid of this indicator 9, the drive pulley 4 and thus the rotating bonding head can be positioned precisely in a zero or initial position. This makes assembly procedures, such as exchanging of the toothed belt, considerably easier.

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SYSTEM FOR LIMITING ROTATING ANGLESLegend

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|----|----|----------------|
| 5 | 1 | Drive Motor |
| | 2 | Drive Pulley |
| | 3 | Toothed Belt |
| | 4 | Drive Pulley |
| 10 | 5 | Holding Device |
| | 6 | Gear Teeth |
| | 7 | Tracer Pin |
| | 7' | Tracer Pin |
| | 8 | Auxiliary Cam |
| 15 | 8' | Auxiliary Cam |
| | 9 | Indicator |

Patent Claims

1. Device for limiting the rotation angles of rotating component groups or processing units, with a rotating drive comprising an endless and positive-locking power transmission element, preferably a toothed belt, transmitting the rotary motion of a drive motor connected to a drive pulley to the rotating component group, which is rigidly connected to the drive pulley, characterized by the fact, that at least one switching element secured to and rotating synchronously with the drive pulley (4), or connected to the latter, the switching element can be actuated at a predetermined rotation angle by actuator elements connected to the force transmission elements and capable of moving with the latter, whereby the switching element remains in operation, if the predetermined rotation angle position is passed and stops the drive motor (1).
2. Device according to Claim 1, characterized by the fact, that the cams of the toothed belt (3) are used as actuating elements.
3. Device according to Claim 2, characterized by the fact, that the tooth of the toothed belt (3), which would otherwise actuate the switching element, is removed in the position of the switching element within the permissible rotation range of the drive pulley (4).
4. Device according to Claim 1, characterized by the fact, that the actuating elements are designed as auxiliary cams (8, 8') which are connected to the toothed belt (3).
5. Device according to Claim 4, characterized by the fact, that the auxiliary cams (8, 8') are detachable from the toothed belt (3).
6. Device according to Claims 1 to 5, characterized by the



fact, that the switching element is designed as a mechanically actuated tracer pin (7, 7').

- 5 7. Device according to Claim 6, characterized by the fact, that the tracer pins (7, 7'), are embedded radially in the drive pulley (4), interrupting the gear teeth (6).
- 10 8. Device according to Claim 6 and 7, characterized by the fact, that the tracer pins (7, 7') are arranged on the drive pulley (4) in such a way, that their actuation takes place in the predetermined position of the rotation angle, when the toothed belt (3) meets the drive pulley (4) tangentially.
- 15 9. Device according to Claims 1 to 5, characterized by the fact, that the switching element is designed as an optically or electromagnetically actuated switch.
- 20 10. Device according to Claims 1 to 10, characterized by the fact, that the distance between the two actuating elements (8, 8') on the toothed belt (3) corresponds to the distance, which a fixed point on the drive pulley (4) travels during a rotation by a predetermined angle value.
- 25 11. Device according to Claims 1 to 10, characterized by the fact, that the drive pulley (4) is equipped with an indicator (9) for the determination of the zero position.
- 30 12. Device according to Claims 1 to 11, characterized by the fact, that the drive pulley (4) or the drive pulley (2) are equipped with a brake actuated by the tracer pins (7, 7').