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(54) **THREAD ROLLING HEAD WITH ENERGY GENERATION APPARATUS**

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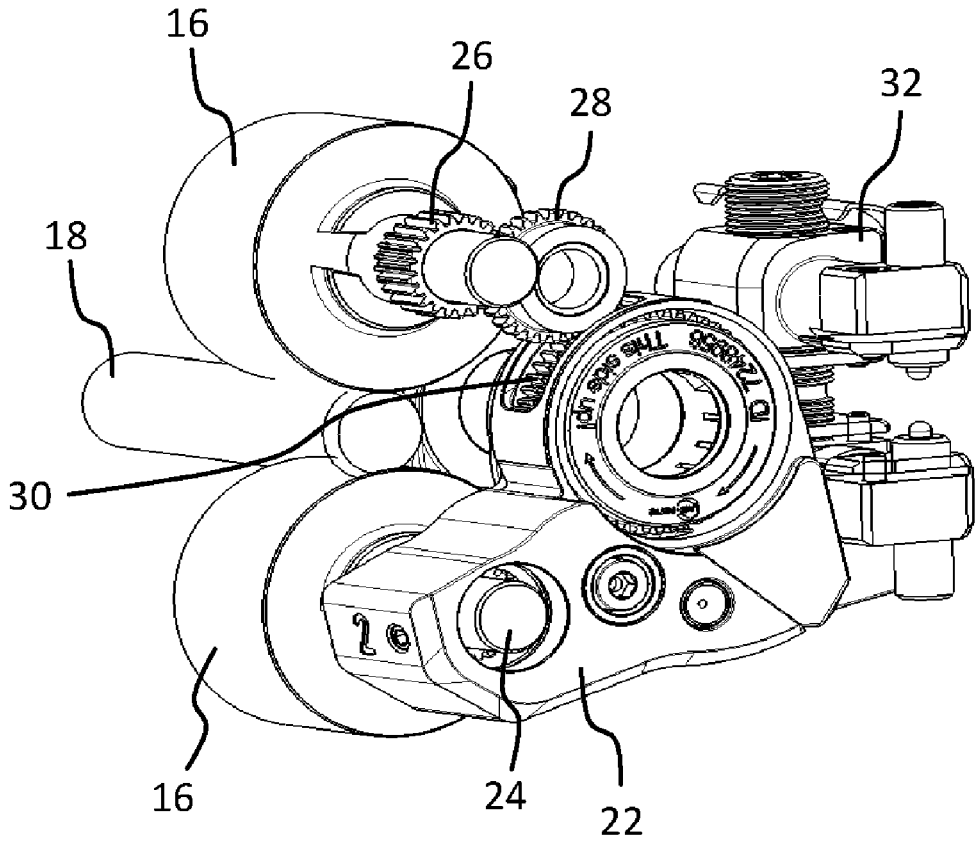
(57) **ABSTRACT**

A thread rolling head comprises at least one roller holder configured to retain rollers that are configured to form a screw thread on a workpiece. The rollers are configured to rotate in the course of the screw thread formation. The thread rolling head further comprises an energy generating apparatus integrated into the thread rolling head that is configured to generate electrical energy when the thread rolling head is operating.



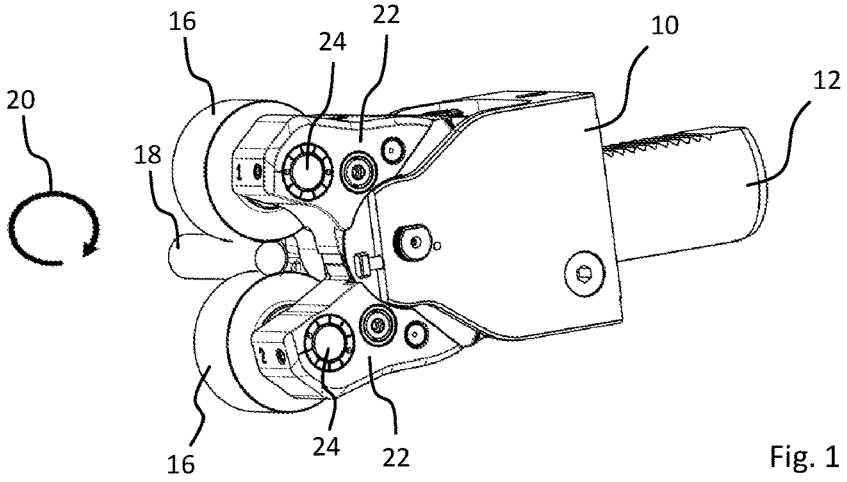


Fig. 1

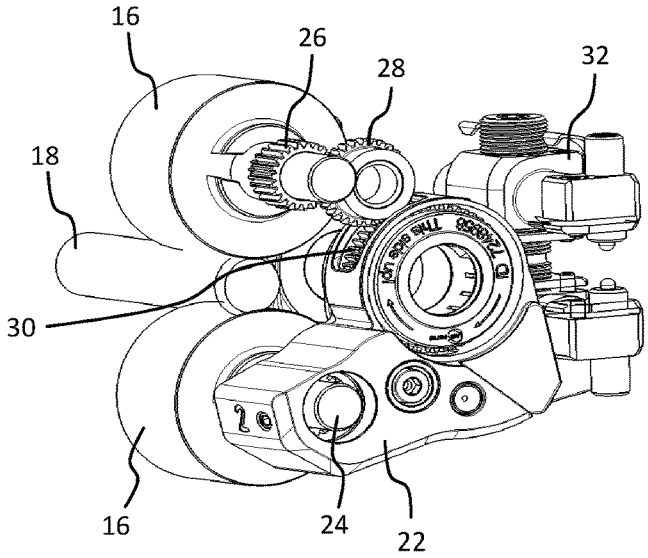


Fig. 2

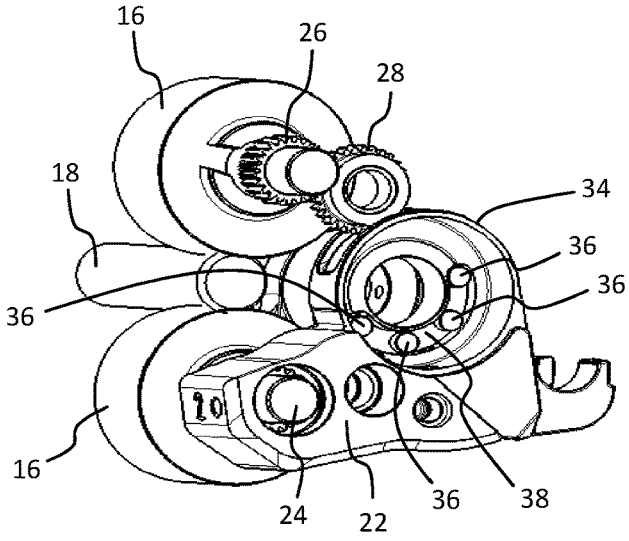


Fig. 3

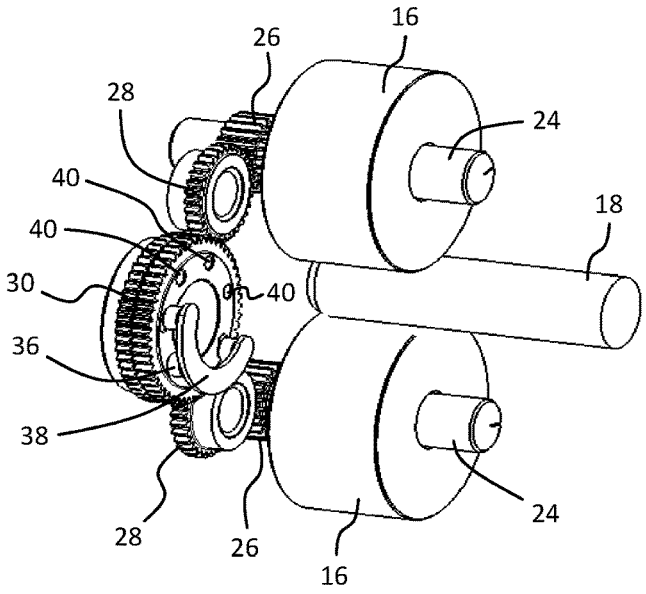


Fig. 4

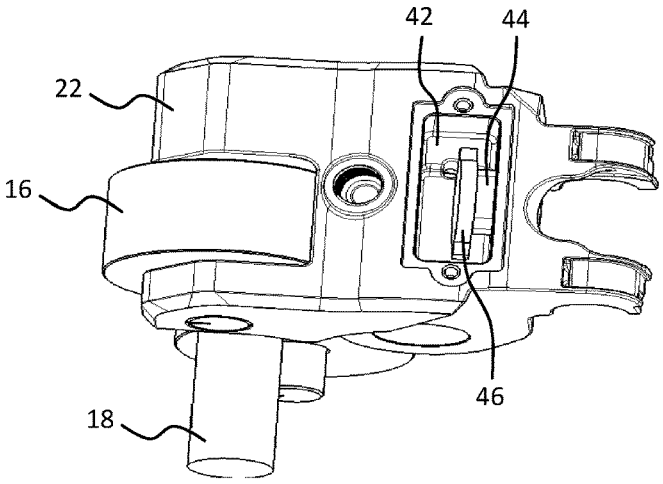


Fig. 5

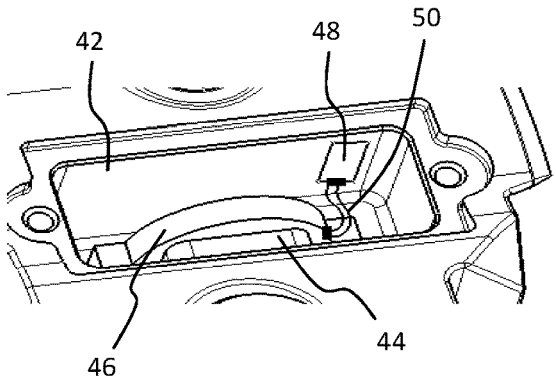


Fig. 6

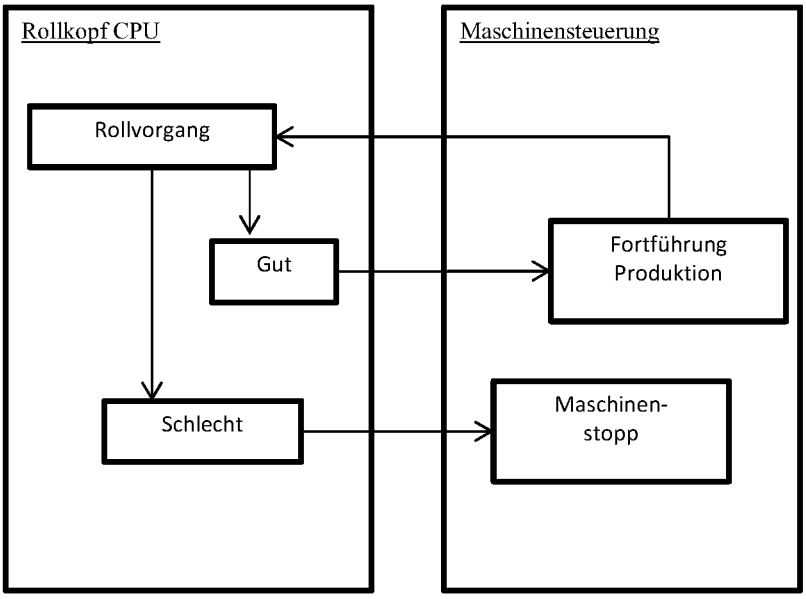

Rollkopf CPU
Maschinensteuerung
Rollvorgang
Gut
Schlecht
Fortführung Produktion
Maschinen-stopp

Fig. 7

THREAD ROLLING HEAD WITH ENERGY GENERATION APPARATUS

CROSS REFERENCE TO RELATED INVENTION

[0001] This application is based upon and claims priority to, under relevant sections of 35 U.S.C. § 119, European Patent Application No. 17 208 446.9, filed Dec. 19, 2017, the entire contents of which are hereby incorporated by reference.

BACKGROUND

[0002] The invention relates to a thread rolling head comprising at least one roller holder for retaining rollers for forming a screw thread on a workpiece, wherein the rollers rotate in the course of the formation of screw threads.

[0003] Axial thread rolling heads, radial thread rolling heads and tangential thread rolling heads are known. They are based on the principle of cold forming, wherein an outer screw thread is formed in a cylindrical workpiece, for example, by the rolling of the thread rolling head. The rollers rotate during the formation of the threads.

[0004] A radial thread rolling head is known from EP 2 014 389 B1. Radial thread rolling heads have a locking mechanism that is released by the workpiece or by an actuating lever, for example, before a rolling process. Only once the locking mechanism has been released can the workpiece be introduced between the rollers for machining. In the radial thread rolling head known from EP 2 014 389 B1, an electromagnet is arranged in the rolling head and is coupled with the locking element. Moreover, an electrical energy source and two switches are located in the radial thread rolling head. One switch actuates a relay that connects the electromagnet to the energy source when a switch is actuated by the workpiece or another actuation device. With the aid of the electromagnet, the locking element of the locking device can be disengaged, and so the drive device can initiate a rotation of the rollers. The electrical energy source comprises a battery and a capacitor that is connected to the battery. The capacitor can store and dispense the energy that must be briefly applied for the actuation of the electromagnet.

[0005] Proceeding from the described prior art, the invention addresses the object of providing a thread rolling head of the aforementioned type that exhibits increased energy efficiency.

BRIEF SUMMARY OF THE INVENTION

[0006] For a thread rolling head of the aforementioned type, the invention solves the object by integrating an energy generation apparatus, which generates electrical energy while the thread rolling head is operating, into the thread rolling head.

[0007] As was explained before, screw threads are formed on cylindrical workpieces, for example, by means of thread rolling heads. The rollers of the thread rolling head create the thread rotate during the machining. The rotation of the rollers can be brought about, for example, by the workpiece, which is rotatably driven during the machining. The thread rolling head thus does not require a rotary drive specifically for the rollers. The thread rolling head can be an axial thread rolling head, a radial thread rolling head or a tangential thread rolling head, for example. Thread rolling heads such as these are generally well known and differ substantially in terms of the relative direction of movement between the workpiece and rollers during the machining. Thus the workpiece that is to be machined is introduced in an axial, radial or tangential direction, depending upon the thread rolling head.

[0008] In an embodiment, an energy generation apparatus is integrated into the thread rolling head. Said device generates energy from the operation of the thread rolling head. The energy generation apparatus forms an energy converter. It converts energy that is generated during the operation of the thread rolling head, e.g. to rotate the rollers or components connected to the rollers (mechanical energy) or e.g. a temperature that is increased as a result of the operation (thermal energy) into electrical energy, which can then be used. For example, the mechanical or thermal energy that would otherwise be unused can be made usable in this way. The energy efficiency of the thread rolling head is thereby increased. For example, it is possible to omit batteries, which must otherwise be regularly replaced, from electrical consumers or electrical component arranged in the thread rolling head.

[0009] The energy generation apparatus can generate electrical energy in an especially efficient way from the movement of at least one component of the thread rolling head that is moved during the operation of the thread rolling head. Mechanical energy that would otherwise be lost is thus converted into electrical energy. Owing to the significant amount of mechanical kinetic energy that would otherwise be lost during the operation of the thread rolling head, this configuration permits particularly extensive energy generation.

[0010] For example, the energy generation apparatus can generate electrical energy from the rotation of the rollers or from a component of the thread rolling head that is rotated with the rollers. An especially large quantity of energy is contained in the rotational movement of the rollers and/or a component rotated with the rollers during the operation of the thread rolling head, and so an especially large amount of electrical energy can accordingly be generated.

[0011] The energy generation apparatus according to the invention can generate the electrical energy by means of induction. In particular, the energy generation apparatus can comprise at least one electrical coil and at least one magnet, in particular a permanent magnet, which is rotated relative to the at least one electrical coil when the rollers or a component of the thread rolling head that rotates with the rollers are rotating. In this way, the rotational movement of the rollers or of the component that rotated with the rollers can be utilized contactlessly and efficiently to generate energy according to the invention.

[0012] The component of the thread rolling head that is rotated by the rollers can be a gear wheel, in particular a toothed gear wheel, that couples the rollers together. Thread rolling heads often have a gear that couples the rotational movements of the rollers together. For example, the thread rolling head can be a tangential thread rolling head. Tangential thread rolling heads are normally passive, i.e. they do not have a dedicated drive for their rollers. Instead, the rollers are rotated by the workpiece, which is rotatably driven and engaged with the rollers during the machining. In a tangential thread rolling head, in the course of being introduced tangentially, the workpiece initially enters into rotating engagement with a first of e.g. two rollers of the

tangential thread rolling head so that this roller rotates first. A gear of the tangential thread rolling head ensures that this rotational movement is transferred synchronously to the second roller. The energy generation is especially efficient in a tangential thread rolling head, since the toothed gear wheel or wheels rotate(s) at all times during the machining process. Thus energy can be generated from this rotational movement throughout the machining. On the other hand, in axial or radial thread rolling heads, for example, a gear usually does not rotate throughout the machining process, but rather only during the opening and closing of the thread rolling head.

[0013] In principle, the energy generation apparatus can also include at least one piezo element and/or at least one thermal element and/or at least one vibration element. Energy can be generated from the operation of the thread rolling head in the manner according to the invention by means of elements such as these, as well. For example, when a mechanical voltage arises in piezo elements, as can occur during the operation of the thread rolling head, an electrical current can occur, which can be used in the manner according to the invention. This also applies to vibration elements. Thermal elements, on the other hand, form an electrical current when temperature differences occur between two sections of the thermal element. In this way, an increased temperature in a component of the thread rolling head brought about by the operation of the thread rolling head, for example, can be used to generate energy according to the invention. A coolant partially flows through thread rolling heads of the type according to the invention during operation. In a thread rolling head of this type, the energy generation apparatus could also have a turbine, which is arranged in the coolant stream and is coupled with an electrical generator. This turbine then generates electrical energy according to the dynamo principle as a result of the rotational movement imposed upon the turbine by the flow of coolant.

[0014] Furthermore, at least one battery, which is electrically charged by the energy generation apparatus, can be integrated into the thread rolling head. Thus, in this embodiment, the electrical energy that is generated and/or converted according to the invention is stored in a battery. It can thus also be used when the thread rolling head is not (or no longer) in operation. In this way, electrical consumers or electrical components that may possibly be arranged in the thread rolling head can be active independently of an operation of the thread rolling head.

[0015] Moreover, at least one electrical consumer, which is supplied with the electrical energy generated by the energy generation apparatus, can be integrated into the thread rolling head. The consumer can be powered directly from the energy generation apparatus or preferably supplied indirectly from a battery that is charged by the energy generation apparatus.

[0016] According to a further embodiment, the electrical consumer can be at least one microprocessor and/or at least one sensor for detecting data about the thread rolling head and/or the machining process. The microprocessor can form a CPU (central processing unit). Sensors can be force sensors, for example, such as strain gauges, temperature sensors or position or motion sensors, such as Hall sensors. A measurement apparatus that measures and evaluates the electrical energy generated by the energy generation apparatus, such as an electric voltage, can also be provided as a sensor. Using this kind of measurement, the measurement apparatus can determine, for example, the number of rolling processes that have been performed with the thread rolling head or the rotational speed of the rollers during a machining procedure. Based on the measured data from the at least one sensor, conclusions can be drawn about the state of the thread rolling head, such as wear or damage, and the machining process, such as whether it is an acceptable or unacceptable machining process.

[0017] According to a further embodiment, the at least one electrical consumer can be configured to transmit data about the thread rolling head and/or the machining process to a machine controller, which is configured separately from the thread rolling head, and/or to a mobile communications unit, which is configured separately from the thread rolling head. The mobile communications unit can be a smartphone, for instance. In particular, the electrical consumer can be the microprocessor that receives measured data from at least one sensor and relays them to the machine controller and/or the mobile communications unit or that already evaluates the measured data obtained from the at least one sensor and relays the evaluation results to the machine controller and/or the mobile communications unit. Data of this type can be previously available static data about the thread rolling head with regard to the electrical consumer, e.g. the microprocessor (serial number, production date, equipment, etc.) and/or dynamic data (number of rolling processes, rotational speed of the rollers during the machining, temperature measurements, force measurements, position measurements, etc.). As was mentioned earlier, the microprocessor can evaluate the received data itself and relay the results of the evaluation to the machine controller and/or to the mobile communications unit. However, it is also plausible that this evaluation takes place in the machine controller and/or in the mobile communications unit or a further evaluation device, which is separate from the machine controller and the thread rolling head. This evaluation device could then be linked to the thread rolling head, either wirelessly or by wire. If the microprocessor performs the evaluation itself, then it also forms an evaluation apparatus, which is integrated into the thread rolling head. The force measurements can be pressing force measurements, for example. The microprocessor can also send a warning signal or stop signal to the machine controller and/or the mobile communications unit on the basis of the data received and/or evaluated by the at least one sensor so that a machine operator can intervene in the process, e.g. the operator can stop said process, or the machine controller and/or the mobile communications unit automatically carries out such a stop based on a stop signal.

[0018] It is especially preferable that the at least one electrical consumer and the machine controller and/or the mobile communications unit can communicate wirelessly. Possible wireless communication options include Bluetooth or NFC (near field communication), for example, but also WiFi or another form of wireless communication. Alternatively, wire-based communication between the electrical consumer and the machine controller and/or the mobile communications unit would, of course, also be plausible.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] An exemplary embodiment of the invention will be explained below on the basis of drawings. The following is shown schematically:

[0020] FIG. **1** illustrates a perspective view of an embodiment of a thread rolling head;

[0021] FIG. **2** illustrates an enlarged view of the embodiment of the thread rolling head shown in FIG. **1**;
[0022] FIG. **3** illustrates another enlarged view of the embodiment of the thread rolling head shown in FIG. **1**;
[0023] FIG. **4** illustrates a view of the embodiment of the thread rolling head shown in FIG. **1** without roller holders;
[0024] FIG. **5** illustrates a rotated view of the embodiment of the thread rolling head shown in FIG. **3**;
[0025] FIG. **6** illustrates an enlarged view of the embodiment of the thread rolling head shown in FIG. **5**; and
[0026] FIG. **7** illustrates a schematic representation of the function of the thread rolling.
[0027] Unless otherwise indicated, the same reference signs identify the same objects in the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0028] The thread rolling head shown in FIG. **1** is a tangential thread rolling head with a housing **10** and a clamping section **12** for clamping into a machine tool. The thread rolling head comprises two rollers **16** for forming an outer screw thread on a cylindrical workpiece **18**. During the formation of the thread, the cylindrical workpiece **18** is rotated by a drive apparatus, which is not represented in greater detail, as is indicated by arrow **20**. The rollers **16** have an outer contour, which forms an outer screw thread on the workpiece **18** by cold forming. Each of the rollers **16** is supported by a roller holder **22**.
[0029] For illustrative purposes, the housing **10** with the clamping section **12** and the upper roller holder **22** as well as a bearing of the lower roller holder **22** are not shown in FIG. **2**. It can be recognized here that an outer tooth system **26** or gear mechanism is formed on each rotary shaft **24**, which co-rotates with the rotary shaft **24** when the roller **16** is rotating. Each of the tooth systems **26** is engaged with an intermediate gear **28**, which in turn is engaged with a central gear **30**. The central gear **30** forms a gear wheel **30**. The two rollers **16** are coupled to each other by the gearing mechanism formed in this way, and so their rotational movement is synchronized.
[0030] For additional illustrative purposes, the central gear **30** is also not shown next to the diameter adjustment unit **32** in FIG. **3**. Electrical coils **36** stationarily arranged on a housing section **34** which accommodates the central gear **30** can be seen here. The electrical coils **36** are retained on a semicircular mount **38** or mount. This can also be seen in FIG. **4**, which shows a view of the thread rolling head without the roller holders **22** and other housing components and rotated by 180° relative to FIG. **3**. In this view, it is also possible to discern that a plurality of permanent magnets **40**, which are evenly distributed over the circumference, are embedded in the central gear **30** on a side opposite the electrical coils **36** and their mount **38**. A rotation of the rollers **16** that is brought about by the rotatably driven workpiece **18** and thus by the gearing mechanism **26** and the intermediate gears **28** of the central gear **30** thus results in the permanent magnets **40** along the arrangement of the electrical coils **36** being rotated past them. An electric voltage is thereby induced in a conventional manner and is supplied to a battery **44**, which is integrated into a receptacle **42** in the thread rolling head and can be recognized in the example shown in FIG. **5**, so that the battery **44** is charged.
[0031] Also arranged in the receptacle **42** is a microprocessor **46**, from which the battery **44** is powered. Additionally, a strain gauge **48** that is linked to the microprocessor **46** by electrical lines **50** can be recognized in FIG. **6**. During operation, a force measurement can be made by means of the strain gauge **48**, wherein the measurement results are provided to the microprocessor **46** via the electrical lines **50**. The microprocessor can draw conclusions about the quality of the respective rolling process, for example, from these measured values and possibly from measured values from other sensors integrated into the thread rolling head. For example, the microprocessor **46** (CPU) can use a wireless connection, such as Bluetooth or NFC, to transmit the results of classifying the rolling process into a good process or a bad process to a machine controller, which is arranged separately from the thread rolling head, as is illustrated in FIG. **7**. If a rolling process is classified as a good process, for example, then the machine controller can transmit the signal to continue production to the microprocessor **46** of the thread rolling head, as is likewise represented in FIG. **7**. On the other hand, if the rolling process is classified as a bad process, the machine controller can trigger a machine stop so that the process is not continued, as is likewise shown in FIG. **7**.

LIST OF REFERENCE SIGNS

[0032] Housing
[0033] Clamping section
[0034] Rollers
[0035] Workpiece
[0036] Arrow
[0037] Roller holder
[0038] Rotary shaft
[0039] Outer tooth system
[0040] Intermediate gear
[0041] Central gear
[0042] Diameter adjustment unit
[0043] Housing section
[0044] Electrical coils
[0045] Mount
[0046] Permanent magnets
[0047] Receptacle
[0048] Battery
[0049] Microprocessor
[0050] Strain gauge
[0051] Electrical lines

1. A thread rolling head comprising:
at least one roller holder configured to retain rollers that are configured to rotate to form a screw thread on a workpiece; and
an energy generating apparatus integrated into the thread rolling head configured to generate electrical energy when the thread rolling head is operating.

2. The thread rolling head according to claim **1**, wherein the energy generation apparatus generates electrical energy from movement of at least one component of the thread rolling head during operation of the thread rolling head.

3. The thread rolling head according to claim **2**, wherein the energy generation apparatus generates electrical energy from the rotation of the rollers.

4. The thread rolling head according to claim **2**, wherein the energy generation apparatus generates electrical energy by means of induction.

5. The thread rolling head according to claim **4**, wherein the energy generation apparatus comprises:

at least one electrical coil; and

at least one magnet that is configured to rotated relative to the at least one electrical coil when the at least one component of the thread rolling head is moved during operation of the thread rolling head.

6. The thread rolling head according to claim **5**, wherein the at least one component of the thread rolling head is a gear wheel configured to couple the rollers together.

7. The thread rolling head according to claim **1**, wherein the thread rolling head is a tangential thread rolling head.

8. The thread rolling head according to claim **1**, wherein the energy generation apparatus further comprises at least one of a piezo element, a thermal element and a vibration element.

9. The thread rolling head according to claim **1**, further comprising at least one battery integrated into the thread rolling head and configured to be electrically charged by the energy generation apparatus.

10. The thread rolling head according to claim **9**, further comprising at least one electrical component integrated into the thread rolling head and configured to be supplied with the electrical energy generated by the energy generation apparatus.

11. The thread rolling head according to claim **10**, wherein the electrical component is at least one of a microprocessor and a sensor configured to detect data about at least one of a thread rolling head and a machining process.

12. The thread rolling head according to claim **10**, wherein the at least one electrical component is configured to transmit data about at least one of the thread rolling head and a machining process to at least one of a machine controller and a mobile communications unit.

13. The thread rolling head according to claim **12**, wherein the at least one electrical component is configured to be wirelessly connected to at least one of the machine controller and the mobile communications unit.

14. The thread rolling head according to claim **2**, wherein the energy generation apparatus generates electrical energy from a component of the thread rolling head that is rotated with the rollers.

15. A method of generating energy with a thread rolling head, the method comprising:

providing at least one roller holder configured to retain rollers;

providing an energy generating apparatus integrated into the thread rolling head;

rotating the rollers during operation of the thread rolling head to form a screw thread on a workpiece; and

generating energy by the energy generating apparatus when the thread rolling head is in operation.

* * * * *