Apparatus for torque wrench with tightening angle measurement function

Apparatus suitable for being applied to a torque wrench for tightening connecting parts such as screws, nuts or the like, comprising an electronic gyroscope, a temperature sensor, a torque transducer and a logic unit able to process the data detected by the said components. Wrench equipped with said apparatus and method of use thereof.
The present invention relates to a torque wrench equipped with a gauge for measuring the tightening angle, the tightness of the screws, bolts and the like, and in particular for manual tightening. Torque wrenches are widely used in the field of industrial assembly when it is necessary to ensure precise tightening of the connecting parts. These wrenches can be fully mechanical or have an electronic measuring system. In this case, the torque can be viewed, for example, on a display unit and/or an acoustic signalling device may be present to advise when a pre-set torque has been reached.

It is possible that, because of errors or defects in the components, such as machining defects or defects in the seat or gluing, for example due to paint, dirt, or the presence of foreign bodies, errors in assembly, flattened threads or other, the achievement of the pre-set torque is not indicative of effective tightening. Given also the working conditions, which require assembly times to be respected, these problems are unlikely to be detected by the operator, which may result in situations of notable risk.

To overcome this problem the most modern wrenches are equipped with a tightening angle measurement function. In practice, the rotation carried out is measured from when the measured torque
exceeds a certain threshold until it reaches the pre-set torque. This reduces the risk of ineffective tightening. To this end, the torque measuring device is associated with an electronic gyroscope, capable of detecting a speed of rotation around the tightening axis. By combining the speed of rotation at the time when the torque values in the aforesaid range are measured, the tightening angle is obtained, which can be used to evaluate the adequacy of the manoeuvre. This evaluation can be done automatically by the apparatus, according to appropriate preset logics, so as to provide a signal, for example an acoustic signal, once operation is completed successfully, or an error signal, as is the case; alternatively, the values detected can be shown on a display unit to be evaluated by the operator.

The electronic-type gyroscopes usable for devices of the kind described above generally provide a gross signal which is the sum of a tare signal, provided when the rotational speed is zero, with the wrench kept still, and a signal proportional to the effective rotation speed. Tare angular velocity is another name therefor. When the apparatus is switched on, which must be done with the wrench still, or at the operator’s command, the apparatus detects the tare signal, which is then subtracted from the gross signal when the wrench is in use in order to obtain the signal proportional to the angular velocity to be integrated in the way outlined above.

However, the tare signal generally varies over time and, in particular, is significantly sensitive to the temperature of the device, as shown in
Figure 1, which provides an example of an electronic gyroscope tare signal curve according to the temperature. Because of the heat generated by the electronic device, the temperature thereof varies, in general, from when it is switched on, reaching an equilibrium value, which is more or less constant, except for perturbations due to ambient temperature or other. It may take several minutes before this occurs. This would make it necessary to carry out the calibration several times at least during the first few minutes after switching on. While it is reasonable to wait for this during laboratory tests, in the case of use on site or in the workshop or on plants, it is often impossible due to the continuous use of the wrench and the difficulty for the operator to put the wrench down in a sufficiently stable position to ensure the immobility thereof every time. It follows that with the tare signal detected once and for all and then utilised during use, it is not always sufficiently precise, rendering the results not entirely satisfactory, unless long operation delays and notable inconvenience for the operator are accepted, with potential errors. The problems outlined above have now been overcome, according to the present invention, by a device capable of being applied to a torque wrench for tightening connecting parts such as screws, nuts or the like, comprising an electronic gyroscope, a temperature sensor, and a logic unit able to process the data detected by the gyroscope and the sensor. In particular, the unit is able to process data from the sensor
according to a pre-set logic. The unit is also able to process data from a torque transducer appropriately mounted on the wrench.

According to a preferred aspect, the unit is programmable, so that the operation logics can be altered during the calibration stage.

The invention also concerns a torque wrench equipped with a torque transducer able to provide a signal according to the torque applied to a connecting part and the apparatus as defined above.

The invention also concerns a method of tightening connecting parts by means of a wrench comprising the following operations:

detecting the torque applied by the wrench to said element;

detecting a signal from an electronic gyroscope applied to said wrench;

detecting a temperature which is related to the temperature to which said gyroscope is subject and which is measured by a suitable sensor mounted on said wrench;

processing said signal from said gyroscope based on said temperature;

time integration of said processed signal for a given time interval based on the torque detected.

The method may comprise the production of an alert, for example a visual or acoustic signal, relating to the completion of tightening, according to preset criteria, and/or an error alert, as is appropriate.

The invention will now be better illustrated by means of the description of a preferred embodiment, provided in the form of a non-
limiting example, with the help of the accompanying drawings, in which:

figure 1 (already discussed) shows the qualitative performance of the tare signal supplied by an electronic gyroscope based on temperature; figure 2 represents, schematically, a wrench in accordance with the present invention.

The torque wrench can be realised in a similar manner to existing wrenches equipped with an electronic gyroscope and integrated management system, except for the modifications outlined above.

With reference to figure 2, a wrench is shown for the manual tightening of screws or bolts, having a seat 1 able to house and turn the head of the screw or bolt. As usual, if so desired, it is possible for the seat to comprise an interchangeable bushing in order to be able to use the wrench with different sizes of screw or bolt. Between the seat and the arm 2 a transducer is mounted, which is able to emit a signal according to the torque applied thereto. The wrench can be equipped with a handgrip 4 and a body 3 which houses an apparatus comprising an electronic gyroscope for measuring the angular velocity about the axis of rotation of the screw or bolt, a temperature sensor able to detect a temperature indicative of the temperature to which the gyroscope is subject; the sensor can be integrated into the said gyroscope, or be placed in an appropriate position. Said sensor may be any kind of sensor, but preferably one that is able to provide an electrical signal, for example, a resistance sensor. The device
includes a logic unit, for example, an appropriate type of processor, which is preferably programmable and equipped with an appropriate type of memory. The logic unit is connected in an appropriate manner to the transducer, the sensor, and the gyroscope. The apparatus may comprise a display unit 5 to display unit data and sound signal emitting devices. Operation of the apparatus is similar to that of apparatus according to the commonly known technique, except for the fact that the tare signal, which is subtracted (algebraic subtraction) from the gross signal issued by the gyroscope (possibly by the logic unit), is determined based on the temperature detected by the sensor, according to a preset logic, for example, a function which assigns a tare signal value to a temperature value. This function or logic may be given a fixed construction datum by the logic unit, for example, it may be a non-modifiable memory, or, preferably, it can be stored in a memory that can be modified, for example, during a periodic calibration of the apparatus, which can be carried out every few months, as per requirements. According to a preferred aspect, the logic unit has a calibration function which can be activated, wherein it stores torques consisting of a signal value from the gyroscope with the value of the signal issued simultaneously by the temperature sensor. By keeping the apparatus still during calibration thereof and varying the temperature in an appropriate manner within the interval concerned, it is possible to store an appropriate number of torques to associate a sufficiently precise tare signal value with any temperature,
said tare signal being then usable during operation. These pairs of values, stored and processed in an appropriate form, may be used until the next calibration of the system. In this way, calibration is not even necessary when switching on, or more frequently, during use of the wrench. This eliminates problems due to variation of the gyroscope temperature generated by the operation thereof or by variations of an external origin and also the possibility of systematic errors due to distraction of the operator, who may not have held the wrench still during switching on or calibration. In any event, a calibration check is possible, for example, an instantaneous value of the angular velocity can be shown on the display unit while holding the wrench still, or with a special apparatus function.

The apparatus can be completed with batteries, connectors, for example, for battery charging, depending on the type, or connection ports to allow connection of the apparatus to other machinery, such as computers or display units, for example for data exchange, diagnosis, or monitoring operations. There may be manual controls envisaged, such as keys, for both switching on the apparatus and activating the various functions or, if desired, for manual data entry.

It has been found that satisfactory results, with electronic gyroscopes of the type commonly used in the field, can be obtained by calibration as discussed above, with the apparatus kept still. However, it may also be possible to realise devices able to store and use more complex logics, with a greater number of variables, for
example, calibration curves with different angular velocities, using - of course - appropriate laboratory machinery.

As mentioned, as regards the measurement of the tightening angle, according to the effective angular velocity and the torque data measured thanks to the transducer, and for displaying or reporting data to the operator, the apparatus can operate in a similar way to apparatus according to the commonly known technique, without the temperature sensor.
CLAIMS

1. Apparatus suitable for being applied to a torque wrench for tightening connecting parts such as screws, nuts or the like, comprising an electronic gyroscope, a temperature sensor, a logic unit able to process the data detected by the gyroscope and the sensor.

2. Apparatus according to Claim 1, wherein said unit is able to process a signal supplied by the gyroscope in relation to the temperature detected by the sensor.

3. Apparatus according to any one of the preceding claims, wherein said unit is provided with a programmable memory and is able to process the data supplied by the sensor using a stored logic.

4. Apparatus according to any one of the preceding claims, able to process data supplied by a torque transducer suitably mounted on the wrench.

5. Apparatus according to any one of the preceding claims, wherein said unit is provided with a calibration function in which the unit may store values of a signal supplied by the gyroscope.

6. Torque wrench provided with a torque transducer able to emit a signal depending on the torque applied to a connecting part and an apparatus according to any one of the preceding claims.

7. Method for tightening connecting parts by means of a wrench,
comprising the following operations: detecting the torque applied by the wrench to said element;
detecting a signal from an electronic gyroscope applied to said wrench;
detecting a temperature which is related to the temperature to which said gyroscope is subject and which is measured by a suitable sensor mounted on said wrench;
processing said signal from said gyroscope based on said temperature;
time integration of said processed signal for a given time interval based on the torque detected.

8. Method according to Claim 7, wherein said processing consists in subtraction, from a gross signal supplied by the gyroscope, of a tare signal associated with said temperature according to a predefined logic.

9. Method according to Claim 7 or 8, wherein a visual or sound signal relating to the outcome of a tightening operation is emitted by a suitable apparatus.
INTERNATIONAL SEARCH REPORT

INTERNATIONAL APPLICATION N o
PCT/IB2011/052131

A. CLASSIFICATION OF SUBJECT MATTER

INV. B25B23/142
ADD. 

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B25B G01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C

See patent family annex

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Date of the actual completion of the international search

22 July 2011

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