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(54) A SYSTEM FOR PRE-TENSIONING A JOINT COMPRISING A NUMBER OF THREADED ELEMENTS

SYSTEM ZUR VORSPANNUNG EINER VERBINDUNG MIT EINER ANZAHL VON GEWINDEELEMENTEN

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EP 3 389 929 B1

Description

Technical field

[0001] The invention relates to a system for pre-tensioning a joint comprising two or more threaded fasteners. In particular, the invention concerns a system in which two or more power wrenches are arranged to simultaneously tighten two or more threaded fasteners in a synchronized way in order to obtain an evenly distributed clamping force in the joint.

Background

[0002] In a system in which two or more power wrenches are arranged to simultaneously tighten two or more threaded fasteners in a synchronized way in order to obtain an evenly distributed clamping force in the joint there is conventionally used two or more power wrenches connected via cables to a common operation control unit to accomplish an individual control of each power wrench in relation to the operation of the other power wrench or wrenches to thereby obtain a synchronized tightening of the threaded fasteners and, hence an evenly distributed clamping force in the joint. While the existing systems work well, there is a constant desire to improve upon the existing systems.

[0003] Hence, there is a need for an improved system for pre-tensioning a joint comprising two or more threaded fasteners.

[0004] The EP 2421679 B1 discloses a tightening assembly for tightening two fasteners. The torque of the tightening assembly is provided by electric, pneumatic or hydraulic energy and can be adjusted via switches.

[0005] The US 4081037 discloses a control system for a multiple spindle machine for simultaneously tightening a plurality of threaded fasteners.

Summary

[0006] It is an object of the invention to provide an improved system for pre-tensioning a joint by simultaneous and synchronized tightening of two or more threaded fasteners by means of two or more manually supported power wrenches at an improved safety and flexibility.

[0007] A further object of the invention is to provide an improved system for pre-tensioning a joint including two or more threaded fasteners by simultaneous and synchronous tightening of the threaded fasteners by two or more manually supported power wrenches communicating with at least one common operation control unit, wherein the system is adaptable to different applications by an increased flexibility.

[0008] At least one of these objects or other objects are obtained by the invention as set out in the appended claims.

[0009] As has been realized by the inventor, existing systems in which two or more power wrenches are connected via cables to a common control unit have been rather awkward to use, particularly in applications including difficult-to-reach positions where the cables have caused both risky and complicated working situations for the operator or operators, for instance at mounting of lids on large containers, tanks etc. If the cables were removed at least some of these drawbacks could be removed or reduced.

[0010] In accordance with a first aspect of the invention, a system for pre-tensioning a joint including two or more threaded fasteners by a synchronized tightening of the threaded fasteners is provided. The system comprises two or more torque delivering power wrenches. Each one of the power wrenches is a manually supported impulse type power wrench. Further each one of the power wrenches is battery powered and comprise a wireless communication module. Each of the power wrenches comprises at least one operation control unit, which comprises a wireless communication module for communicating with the wireless communication modules of the power wrenches to receive operation data from each power wrench and to deliver data to each power wrenches controlling the tightening operation of at least one power wrench in response to the received operation data from the respective power wrenches. Hereby it is achieved that the control of the power wrenches can be performed wirelessly but still in synchronization.

[0011] In accordance with one embodiment at least one power wrench is controlled to perform a step-wise tightening operation synchronized with a step-wise tightening operation of the other power wrench or wrenches of the system.

[0012] In accordance with one embodiment a number of the power wrenches are arranged in two or more groups for pre-tensioning a multi-fastener joint, and the power wrenches in each group are controlled to perform a simultaneous tightening operation to match in a synchronized way the tightening operation of the power wrenches in another group or groups.

[0013] In accordance with one embodiment the at least one operation control unit comprises a separate operation control unit provided at or inside each one of the power wrenches, each one of said separate operation control units is arranged to wirelessly communicate with the separate operation control unit or units of the other power wrench or wrenches of the system.

[0014] In accordance with one embodiment at least one operation control unit comprises a single operation control unit communicating with and controlling all of the power wrenches in the system.

[0015] In accordance with a second aspect of the invention a control unit for controlling pre-tensioning a joint including two or more threaded fasteners by a synchronized tightening of the threaded fasteners by two or more torque delivering power wrenches is provided. The control unit is in communication with the power wrenches for control of the operation of at least one of the power wrenches. The operation control unit comprises a wire-

less communication module for communicating with a wireless communication module of the power wrenches. The control unit is adapted to receive operation data from each power wrench and to deliver data to each power wenches controlling the tightening operation of at least one power wrench in response to the received operation data from the respective power wrenches.

[0016] In accordance with one embodiment the control unit is adapted to control the at least one power wrench to perform a step-wise tightening operation synchronized with a step-wise tightening operation of at least one other power wrench used in a synchronized tightening of the threaded fasteners.

[0017] In accordance with one embodiment, when a number of the power wrenches controlled by the unit are arranged in two or more groups for pre-tensioning a multi-fastener joint, the control unit is adapted to control the power wrenches in each group to perform a simultaneous tightening operation to match in a synchronized way the tightening operation of the power wrenches in another group or groups.

[0018] In accordance with one embodiment the control unit is a stand-alone device.

[0019] In accordance with one embodiment the control unit is a separate operation control unit provided at or inside a power wrench. The control unit is arranged to wirelessly communicate with at least one other separate operation control unit.

[0020] In accordance with a third aspect a power wrench provided with a wireless communication module adapted to wirelessly transmit operation data from a synchronized tightening of the threaded fasteners performed by the power wrench and at least one other power wrench is provided.

[0021] In accordance with one embodiment the wireless communication module is adapted to wirelessly transmit said operation data to a common control unit for control of the synchronized tightening.

[0022] In accordance with one embodiment the wireless communication module is adapted to wirelessly transmit said operation data to the at least one other power wrench.

[0023] In accordance with one embodiment the power wrench comprises a control unit adapted to control a synchronized tightening performed by the power wrench in response to control data wirelessly received from said at least one other power wrench.

[0024] Further objects and advantages of the invention will appear from the following specification and claims.

Brief description of the drawing

[0025] The invention will now be described in more detail by means of exemplary embodiments and with reference to the accompanying drawings, in which

- Fig. 1 illustrates the main components of a system for tightening of two or more threaded fasteners by means of two or more manually supported power wrenches, and
- Fig. 2 is a schematic view of a control unit.

Detailed description

[0026] In Fig. 1 a system 1 for pre-tensioning a joint 13 including two or more threaded fasteners 11a - c by a synchronized tightening of the threaded fasteners is depicted. The system illustrated in Fig. 1 comprises three manually supported and battery powered power wrenches 10 a-c which are to be applied on a number of threaded fasteners 11 a-c. The threaded fasteners 11 a-c are parts of a joint 13 wherein two elements 14, 15 are to be put together by a clamping force obtained by the threaded fasteners 11 a-c. Preferably, the power wrenches 10 a-c are of the torque impulse delivering type which do not generate any reaction forces, which makes it possible for an operator to operate two wrenches at a time. But the power wrenches 10 a-c can also be of the torque delivering type. Each one of the power wrenches 10 a-c carries not only a detachable battery casing but also a non-illustrated internal means for indicating actual operation data like output torque, angular displacement etc. These features are well known in prior art, and are therefore not further described herein.

[0027] Each one of the power wrenches 10 a-c comprises a wireless communication module 16a - c for communication with a common operation control unit 18. Since it is well known per se to provide battery powered power wrenches with equipment for wireless communication with an operation control unit that feature is not described in further detail.

[0028] In Fig. 2, the control unit 18 is schematically shown. The control unit 18 comprises a control circuit programmed with operation data suitable for the actual tightening operation, and a comparing circuit by which the outgoing control data for each power wrench are adapted to the received actual operation data from the other power wrenches. The control circuit and the comparing circuit can for example be implemented using a processor 20 connected to a memory 22 on which a computer program is stored that when executed by the processor causes the control circuit and comparing circuit to perform the above tasks. The control unit 18 is in accordance with one embodiment further arranged to identify the actual status of each one of the wrenches during a tightening sequence to control the tightening operation of the other power wrench or wrenches in response thereto, and to complete the predetermined tightening sequence via a synchronized tightening of the threaded fasteners 11 a-c. The control unit 18 is provided with a wireless communication module 24 adapted to wirelessly transmitting and receiving data to/from the respective power wrenches 10a - 10 c. The wireless communication module can be operatively connected to the control circuit. By such a synchronized tightening there is obtained an evenly distributed clamping force in the joint 13, which

is particularly important at joints having deformable sealing elements in the form of gaskets or the like where it is essential to avoid an uneven setting of such elements.

[0029] According to the the invention the operation control unit is formed by separate control units 18 located at or inside the power wrenches themselves, which means that operation data and identification of the present status of the other power wrenches are received and compared by each one of the separate control units 18 in a distributed manner. This arrangement will contribute to an even more flexible system.

[0030] The synchronized tightening of the threaded fasteners 11 a-c may very well be executed continuously or in steps as long as the tightening operation performed by each one of the power wrenches 10 a-c is kept up with the operation of the other power wrenches to accomplish an evenly distributed clamping force in the joint 13.

[0031] Alternatively, if a number of power wenches are used for pre-tensioning a multi-fastener joint the wrenches could be arranged in groups, whereby a synchronized tightening could be performed by controlling a simultaneous tightening operation of the power wrenches of one group in relation to a simultaneous tightening of the power wrenches in another group or groups. In this case too, the synchronized tightening aims to obtain an evenly distributed clamping force in the joint.

[0032] By providing a system for synchronized tightening of a number of threaded fasteners of a joint by two or more battery powered power wrenches having wireless communication modules for communication with at least one operation control unit it is possible to accomplish a flexible joint pre-tensioning system with no cable related problems as to the adaptability and operation of the system.

Claims

1. A system (1) for pre-tensioning a joint (13) including two or more threaded fasteners (11a -c) by a synchronized tightening of the threaded fasteners, comprising two or more torque delivering manually supported, battery powered, power wrenches (10a - 10c),
characterized in

that each one of the power wrenches comprises a separate operation control unit (18) being arranged to wirelessly communicate with the separate operation control unit or units of the other power wrench or power wrenches of the system, a wireless communication module (16a -c), and **that** the separate operation control unit (18) comprises a wireless communication module (24) for communicating with the wireless communication modules (16a-c) of the power wrenches to receive operation data from each power wrench and to deliver data to each power wrench controlling the tightening operation of at least one power wrench in response to the received operation data from the respective power wrenches, wherein the separate operation control unit (18) further comprises a control circuit programmed with operation data suitable for the actual tightening operation, and a comparing circuit by which the outgoing control data for each power wrench are adapted to the received actual operation data from the other power wrenches in order to complete the predetermined tightening sequence via a synchronized tightening of the threaded fasteners (11a-c).

2. The system according to claim 1, wherein said two or more torque delivering manually supported, battery powered, power wrenches are controlled to perform a step-wise tightening operation synchronized with a step-wise tightening operation of the other power wrench or wrenches of the system.

3. The system according to claim 1 or 2, wherein a number of the power wrenches are arranged in two or more groups for pre-tensioning a multi-fastener joint, and the power wrenches in each group are controlled to perform a simultaneous tightening operation to match in a synchronized way the tightening operation of the power wrenches in another group or groups.

4. The system according to anyone of claims 1-3, wherein each one of the power wrenches is a manually supported impulse type power wrench.

5. A control unit (18) for controlling pre-tensioning a joint (13) including two or more threaded fasteners (11a -c) by a synchronized tightening of the threaded fasteners using two or more torque delivering, manually supported, battery powered, power wrenches (10a - 10c), the control unit being configured to be arranged in each of the power wrenches for communicating with other power wrenches for control of the operation of at least one of the power wrenches,
characterized in
that the control unit (18) comprises a wireless communication module (24) for communicating with a wireless communication module of the power wrenches and being adapted to receive operation data from each power wrench and to deliver data to each power wrench controlling the tightening operation of at least one power wrench in response to the received operation data from the respective power wrenches, wherein the control unit (18) further comprises a control circuit programmed with operation data suitable for the actual tightening operation, and a comparing circuit by which the outgoing control data for each power wrench are adapted to the received actual operation data from the other power

wrenches in order to complete the predetermined tightening sequence via a synchronized tightening of the threated fasteners (11a-c).

6. The control unit (18) according to claim 5, wherein the control unit is adapted to control the power wrench to perform a step-wise tightening operation synchronized with a step-wise tightening operation of at least one other power wrench used in a synchronized tightening of the threaded fasteners.

7. The control unit (18) according to claim 5 or 6, wherein a number of the power wrenches controlled the control units (18) are arranged in two or more groups for pre-tensioning a multi-fastener joint, and wherein the control units are adapted to control the power wrenches in each group to perform a simultaneous tightening operation to match in a synchronized way the tightening operation of the power wrenches in another group or groups.

8. A power wrench (10a -c) comprising a control unit according to anyone of claims 5 to 7, wherein the control unit is arranged to wirelessly communicate with at least one other control unit of at least one other power wrench.

9. The power wrench (10a -c) according to claim 8, **characterized by** a wireless communication module adapted to wirelessly transmit operation data from a synchronized tightening of the threaded fasteners performed by the power wrench and at least one other power wrench.

10. The power wrench (10a -c) according to claim 9, wherein the wireless communication module is adapted to wirelessly transmit said operation data to said at least one other power wrench.

11. The power wrench (10a -c) according to any of claims 8 to 10, wherein each one of the power wrenches is a manually supported impulse type power wrench.

Patentansprüche

1. System (1) zum Vorspannen einer Verbindung (13) einschließlich zwei oder mehr Befestigungselemente (11a-c) mit Gewinde durch ein synchronisiertes Anziehen der Befestigungselemente mit Gewinde, umfassend zwei oder mehr Drehmoment abgebende, manuell getragene, batteriebetriebene Kraftschrauber (10a-10c),
dadurch gekennzeichnet,

dass jeder der Kraftschrauber eine separate Ablaufsteuereinheit (18), die angeordnet ist, um mit der separaten Ablaufsteuereinheit oder den separaten Ablaufsteuereinheiten des anderen Kraftschraubers oder der anderen Kraftschrauber des Systems drahtlos zu kommunizieren, ein Drahtloskommunikationsmodul (16a-c) umfasst, und
dass die separate Ablaufsteuereinheit (18) ein Drahtloskommunikationsmodul (24) zum Kommunizieren mit den Drahtloskommunikationsmodulen (16a-c) der Kraftschrauber umfasst, um Ablaufdaten von jedem Kraftschrauber zu empfangen und um Daten, die den Anziehablauf mindestens eines Kraftschraubers steuern, als Reaktion auf die empfangenen Ablaufdaten von den jeweiligen Kraftschraubern an jeden Kraftschrauber abzugeben, wobei die separate Ablaufsteuereinheit (18) ferner eine Steuerschaltung, die mit Ablaufdaten programmiert ist, die für den tatsächlichen Anziehablauf geeignet sind, und eine Vergleichsschaltung umfasst, durch die die ausgehenden Steuerdaten für jeden Kraftschrauber an die empfangenen tatsächlichen Ablaufdaten von den anderen Kraftschraubern angepasst werden, um die zuvor bestimmte Anziehsequenz über ein synchronisiertes Anziehen der Befestigungselemente (11a-c) mit Gewinde abzuschließen.

2. System nach Anspruch 1, wobei die zwei oder mehr Drehmoment abgebenden, manuell getragenen, batteriebetriebenen Kraftschrauber gesteuert werden, um einen schrittweisen Anziehablauf synchronisiert mit einem schrittweisen Anziehablauf des anderen Kraftschraubers oder der anderen Kraftschrauber des Systems durchzuführen.

3. System nach Anspruch 1 oder 2, wobei eine Anzahl der Kraftschrauber in zwei oder mehr Gruppen zum Vorspannen einer Mehrbefestigungsverbindung angeordnet ist und die Kraftschrauber in jeder Gruppe gesteuert werden, um einen gleichzeitigen Anziehablauf durchzuführen, um in einer synchronisierten Weise dem Anziehablauf der Kraftschrauber in einer anderen Gruppe oder in anderen Gruppen zu entsprechen.

4. System nach einem der Ansprüche 1 bis 3, wobei jeder der Kraftschrauber ein manuell getragener Kraftschrauber einer Impulsart ist.

5. Steuereinheit (18) zum Steuern des Vorspannens einer Verbindung (13) einschließlich zwei oder mehr Befestigungselemente (11a-c) mit Gewinde durch ein synchronisiertes Anziehen der Befestigungselemente mit Gewinde unter Verwendung von zwei oder mehr Drehmoment abgebenden, manuell gestützten, batteriebetriebenen Kraftschraubern (10a-10c), wobei die Steuereinheit konfiguriert ist, um in jedem der Kraftschrauber zum Kommunizieren mit anderen

Leistungsumsätzen für eine Steuerung des Ablaufs mindestens eines der Kraftschrauber angeordnet zu sein,
dadurch gekennzeichnet,
dass die Steuereinheit (18) ein Drahtloskommunikationsmodul (24) zum Kommunizieren mit einem Drahtloskommunikationsmodul der Kraftschrauber umfasst und angepasst ist, um Ablaufdaten von jedem Kraftschrauber zu empfangen und um Daten, die den Anziehablauf mindestens eines Kraftschraubers steuern, als Reaktion auf die empfangenen Ablaufdaten von den jeweiligen Kraftschraubern an jeden Kraftschrauber abzugeben, wobei die Steuereinheit (18) ferner eine Steuerschaltung, die mit Ablaufdaten programmiert ist, die für den tatsächlichen Anziehablauf geeignet sind, und eine Vergleichsschaltung umfasst, durch die die ausgehenden Steuerdaten für jeden Kraftschrauber an die empfangenen tatsächlichen Ablaufdaten von den anderen Kraftschraubern angepasst werden, um die zuvor bestimmte Anziehsequenz über ein synchronisiertes Anziehen der drei Befestigungselemente (11a-c) mit Gewinde abzuschließen.

6. Steuereinheit (18) nach Anspruch 5, wobei die Steuereinheit angepasst ist, um den Kraftschrauber zu steuern, um einen schrittweisen Anziehablauf durchzuführen, der mit einem schrittweisen Anziehablauf mindestens eines anderen Kraftschraubers synchronisiert ist, der bei einem synchronisierten Anziehen der Befestigungselemente mit Gewinde verwendet wird.

7. Steuereinheit (18) nach Anspruch 5 oder 6, wobei eine Anzahl der Kraftschrauber, die durch die Steuereinheiten (18) gesteuert werden, in zwei oder mehr Gruppen zum Vorspannen einer Mehrbefestigungsverbindung angeordnet ist, und wobei die Steuereinheiten angepasst sind, um die Kraftschrauber in jeder Gruppe zu steuern, um einen gleichzeitigen Anziehablauf durchzuführen, um in einer synchronisierten Weise dem Anziehablauf der Kraftschrauber in einer anderen Gruppe oder in anderen Gruppen zu entsprechen.

8. Kraftschrauber (10a-c), umfassend eine Steuereinheit nach einem der Ansprüche 5 bis 7, wobei die Steuereinheit angeordnet ist, um mit mindestens einer anderen Steuereinheit mindestens eines anderen Kraftschraubers drahtlos zu kommunizieren.

9. Kraftschrauber (10a-c) nach Anspruch 8, **gekennzeichnet durch** ein Drahtloskommunikationsmodul, das angepasst ist, um Ablaufdaten von einem synchronisierten Anziehen der Befestigungselemente mit Gewinde, das durch den Kraftschrauber und mindestens einen anderen Kraftschrauber durchgeführt wird, drahtlos zu übertragen.

10. Kraftschrauber (10a-c) nach Anspruch 9, wobei das Drahtloskommunikationsmodul angepasst ist, um die Ablaufdaten an den mindestens einen anderen Kraftschrauber drahtlos zu übertragen.

11. Kraftschrauber (10a-c) nach einem der Ansprüche 8 bis 10, wobei jeder der Kraftschrauber ein manuell getragener Kraftschrauber der Impulsart ist.

Revendications

1. Système (1) de pré-tension d'un joint (13) comportant au moins deux éléments de fixation filetés (11a-c) par un serrage synchronisé des éléments de fixation filetés, comprenant au moins deux boulonneuses (10a-10c), alimentées par batterie, supportées manuellement, fournissant un couple de serrage
caractérisé

en ce que chacune des boulonneuses comprend une unité de commande d'opération séparée (18) qui est disposée pour communiquer sans fil avec la ou les unités de commande d'opération séparées de la ou des autres boulonneuses du système, un module de communication sans fil (16a-c), et
en ce que l'unité de commande d'opération séparée (18) comprend un module de communication sans fil (24) permettant de communiquer avec les modules de communication sans fil (16a-c) des boulonneuses pour recevoir des données d'opération de chaque boulonneuse et pour fournir des données à chaque boulonneuse commandant l'opération de serrage d'au moins une boulonneuse en réponse aux données d'opération reçues à partir des boulonneuses respectives, l'unité de commande d'opération séparée (18) comprenant en outre un circuit de commande programmé avec des données d'opération appropriées pour l'opération de serrage réelle, et un circuit de comparaison par lequel les données de commande sortantes pour chaque boulonneuse sont adaptées aux données d'opération réelles reçues à partir des autres boulonneuses afin d'achever la séquence de serrage prédéterminée par l'intermédiaire d'un serrage synchronisé des éléments de fixation filetés (11a-c).

2. Système selon la revendication 1, lesdites au moins deux boulonneuses alimentées par batterie, supportées manuellement, fournissant un couple de serrage étant commandées pour effectuer une opération de serrage par étapes synchronisée avec une opération de serrage par étapes de la ou des autres boulonneuses du système.

3. Système selon la revendication 1 ou 2, un nombre des boulonneuses étant disposées en au moins deux groupes pour la pré-tension d'un joint à fixations multiples, et les boulonneuses dans chaque groupe étant commandées pour effectuer une opération de serrage simultanée pour correspondre de manière synchronisée à l'opération de serrage des boulonneuses dans un ou plusieurs autres groupes.

4. Système selon l'une quelconque des revendications 1 à 3, chacune des boulonneuses étant une boulonneuse de type à impulsions supportée manuellement.

5. Unité de commande (18) destinée à la commande d'une pré-tension d'un joint (13) comportant au moins deux éléments de fixation filetés (11a-c) par un serrage synchronisé des éléments de fixation filetés à l'aide d'au moins deux boulonneuses (10a-10c) alimentées par batterie, supportées manuellement, fournissant un couple de serrage, l'unité de commande étant configurée pour être disposée dans chacune des boulonneuses afin de communiquer avec d'autres boulonneuses pour commander l'opération d'au moins une des boulonneuses,
caractérisé
en ce que l'unité de commande (18) comprend un module de communication sans fil (24) permettant de communiquer avec un module de communication sans fil des boulonneuses et étant configurée pour recevoir des données d'opération à partir de chaque boulonneuse et pour fournir des données à chaque boulonneuse commandant l'opération de serrage d'au moins une boulonneuse en réponse aux données d'opération reçues à partir des boulonneuses respectives, l'unité de commande (18) comprenant en outre un circuit de commande programmé avec des données d'opération appropriées pour l'opération de serrage réelle, et un circuit de comparaison par lequel les données de commande sortantes pour chaque boulonneuses sont adaptées aux données d'opération réelles reçues à partir des autres boulonneuses afin d'achever la séquence de serrage prédéterminée par l'intermédiaire d'un serrage synchronisé des éléments de fixation filetés (11a-c).

6. Unité de commande (18) selon la revendication 5, l'unité de commande étant adaptée pour commander la boulonneuse afin d'effectuer une opération de serrage par étapes synchronisée avec une opération de serrage par étapes d'au moins une autre boulonneuse utilisée dans un serrage synchronisé des éléments de fixation filetés.

7. Unité de commande (18) selon la revendication 5 ou 6, un nombre des boulonneuses commandées par les unités de commande (18) étant disposées en au moins deux groupes pour la pré-tension d'un joint à fixations multiples, et les unités de commande étant adaptées pour commander les boulonneuses dans chaque groupe afin d'effectuer une opération de serrage simultanée pour correspondre de manière synchronisée à l'opération de serrage des boulonneuses dans un ou plusieurs autres groupes.

8. Boulonneuse (10a-c) comprenant une unité de commande selon l'une quelconque des revendications 5 à 7, l'unité de commande étant disposée pour communiquer sans fil avec au moins une autre unité de commande d'au moins une autre boulonneuse.

9. Boulonneuse (10a-c) selon la revendication 8, **caractérisée par** un module de communication sans fil adapté pour transmettre sans fil des données d'opération à partir d'un serrage synchronisé des éléments de fixation filetés effectués par la boulonneuse et au moins une autre boulonneuse.

10. Boulonneuse (10a-c) selon la revendication 9, le module de communication sans fil étant adapté pour transmettre sans fil lesdites données d'opération à ladite au moins une autre boulonneuse.

11. Boulonneuse (10a-c) selon l'une quelconque des revendications 8 à 10, chacune des boulonneuses étant une boulonneuse à type d'impulsion supportée manuellement.

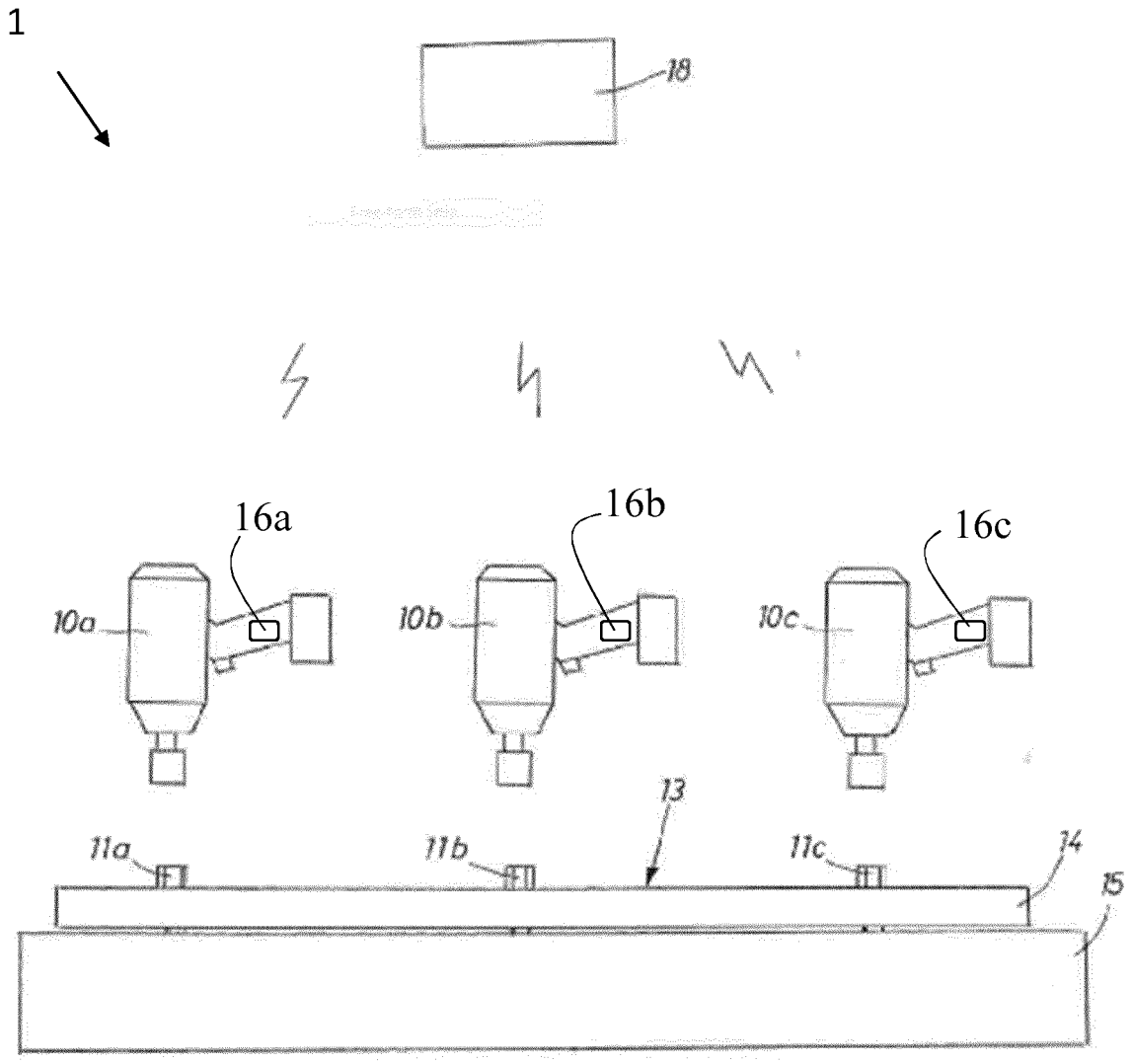


Fig. 1

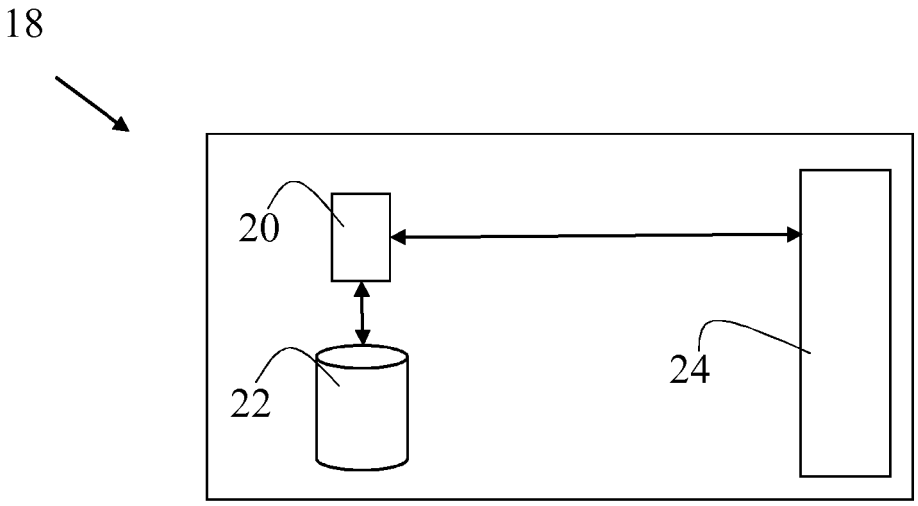


Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2421679 B1 **[0004]**
- US 4081037 A **[0005]**