(19) DANMARK

(10) **DK/EP 2612308 T3**

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *G 08 C 17/02 (2006.01)*

(45) Oversættelsen bekendtgjort den: **2017-07-31**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-04-05**

(86) Europæisk ansøgning nr.: **10757578.9**

(86) Europæisk indleveringsdag: **2010-08-31**

(87) Den europæiske ansøgnings publiceringsdag: **2013-07-10**

(86) International ansøgning nr.: **EP2010062706**

(87) Internationalt publikationsnr.: **WO2012028175**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR**

(73) Patenthaver: **Brendel Holding GmbH & Co. KG, Haller Strasse 45-53, 74564 Crailsheim, Tyskland**

(72) Opfinder: **Brendel, Wolfgang, In den kerzenwiesen 9, 74564 Crailsheim, Tyskland**

(74) Fuldmægtig i Danmark: **Chas. Hude A/S, H.C. Andersens Boulevard 33, 1780 København V, Danmark**

(54) Benævnelse: **Radiofjernstyring med positionssensorindretning**

(56) Fremdragne publikationer:
DE-A1-102004 009 561
US-A1- 2005 212 911
US-A1- 2008 150 749

The present invention relates to a radio remote control system of a crane, a jib, a loading ramp and/or lifting gear having various movable components (machine) with at least one machine drive for a movable machine part, which machine drive can be controlled by the radio remote control system, comprising a radio receiver assigned to the machine, a hand-held unit comprising a control unit, a transmitter and at least one motion sensor, the control unit being configured to communicate control commands issued by a user to the transmitter and to cause the transmitter to transmit the control commands to the receiver, and spatial movements of the hand-held unit about at least one tilt axis or inclined axis (KA, DA) being detectable by the motion sensor in such a way that in a motion control mode, the detected movements can be converted by the control unit into control commands which can be communicated to the machine by radio transmission between transmitter and receiver, it being possible for the motion control mode to be activated by a user input at the hand-held unit.

A field of use of the present invention which is particularly preferred, although not exclusive is the control of cranes and lifting gear. In the example of a jib crane, for example a construction crane, it is possible to control, for example, the orientation of the jib (angle of rotation), the movement of the trolley and the movement of the hook using a suitably configured radio remote control system according to the invention.

It is known to control equipment by means of position sensors in a remote control system or in a component similar to a remote control system. Reference is made by way of example to games consoles or the like. Nowadays, position sensors are also fitted, for example, in mobile phones so that it is possible to determine the orientation of such a device, in particular the orientation of the display thereof, in order to adjust what is shown on the display to the orientation of the device.

Non-generic radio remote control systems which are relevant in respect of the present invention are known from US 2005/0212911 A1, DE 10 2004 009 561 A1 and US 2008/0150749 A1.

US 2005/0212911 A1 generally discloses the configuration or use of a hand-held device, for example a mobile phone, as a radio remote control system for all possible devices, some with movable parts, and the radio remote control system corresponds in functionality to the other features of the preamble of claim 1.

DE 10 2004 009 561 A1 discloses the use of a smart phone as a remote control for controlling a device, detected by the camera, by movements of the smart phone.

US 2008/0150749 A1 discloses a remote control for a lying or sitting device, for example a hospital bed, the lying or sitting surface of which comprises a plurality of elements which can be respectively adjusted separately by a linear motor. The operating mode of the respective linear motors is transmitted back to the remote control.

In order to be able to make optimum use of a radio remote control system for a machine, it is necessary to be able to detect spatial movements of the hand-held unit in a precise manner. It must also be ensured that the radio remote control system enables a machine control that is intuitive to a user using the hand-held unit, in particular if the user is to operate the machine by moving the hand-held unit.

It is the object of the invention to improve a generic radio remote control system with regard to intuitive operation by a user.

In this respect, it is proposed that the receiver has a feedback transmitter and is configured, upon receiving control commands, to activate the feedback transmitter to transmit feedback information, and the hand-held unit has a feedback receiver which is configured to receive the feedback information and is connected to the control unit, as well as an acoustic and/or haptic indication means which is controlled by the control unit and by which operating functional information from the radio remote control system can be indicated according to the receipt of feedback signals from the feedback transmitter.

In such an embodiment of the control unit, it is possible to determine the current reference position in a hand position that is comfortable for a user. A hand-held unit of a radio remote control system is often not held exactly horizontally, but a natural pose of the human hand results in the hand-held unit being held with a slight upwards inclination. This natural pose can then be determined as the current reference position, in other words as a type of neutral position, so that movements detected by the motion sensor, for example movements such as rotation, inclination or tilting of the hand-held unit, can be detected and converted into control commands. Starting from such a natural position of the human hand also results in optimum utilisation of the possible movements by the user for the purpose of controlling a suitable machine drive.

It is preferably proposed that the radio remote control system is configured such that on activating the motion control mode, the current spatial position of the hand-held unit is detected, and is compared with a predetermined reference position, and such that detected movements cannot be communicated to the machine as control commands until the radio remote control system has been brought at least approximately into the predetermined reference position, movements relative to the predetermined reference position being detected for the purpose of generating control commands.

The predetermined reference position may be, for example, a substantially horizontal spatial orientation of the hand-held unit. This predetermined reference position must be reached or adjusted from a spatial position of the hand-held unit in which the motion control system is activated. As soon as the hand-held unit has been brought into a current position, or on activating the motion control system is already in a current position which corresponds approximately to the predetermined reference position, i.e. this predetermined reference position lies within a tolerance range, then further movements of the hand-held unit out of the predetermined reference position are detected and converted into control commands, which can be communicated to the machine.

On its own or with the aforementioned development, the invention enables intuitive operation and control of a machine by means of a hand-held unit which contains motion sensors, and the control unit of which enables communication of detected movements as a control command to the machine.

In this regard, reference should be made to two different control system operating options, which can be realised in relevant embodiments of a radio remote control system according to the present invention. In a first control system operating mode, the motion control mode is activated by operating a switch. This preferably enables a safety-related relay or the like that may be present in the machine, and then the hand-held unit is referenced according to one of the aforementioned referencing options. The movement to be controlled of the machine part is then defined by moving the hand-held unit relative to the detected reference position, it being possible for opposite directions of movement of the hand-held unit relative to the reference position to generate control commands that also cause the machine part to move in correspondingly opposite directions. The magnitude of the movement to be controlled, thus for example the velocity magnitude or acceleration magnitude, can then also be defined by the amplitude of the movement of the hand-held unit relative to the reference position. An example of this is given, for example, in that both the direction and the magnitude of the movement to be controlled of the machine part are defined by rotating the hand-held unit through for example +/-30° relative to a reference position detected when the motion control mode was enabled, where the positive range represents one direction of movement and the negative range represents the opposite direction of movement of the machine part.

A second control system operating mode provides that, for example, two contacts or pushbuttons are provided which must be actuated to activate the motion control mode, where one of the buttons is assigned to one direction of movement of the machine part, while the other button is assigned to the opposite direction of movement of the machine part. Movement of the hand-held unit relative to the relevant reference position would then preset, for example, only the magnitude of the velocity to be controlled of the machine part.

Pushbutton switches, for example, can be provided on the hand-held unit for the purpose of user input. Thus, according to one embodiment of the invention, the motion control mode must be initiated by actuating a switch on the hand-held unit and maintained by continued touching of this switch in order to be able to control the movement of the machine part. Releasing this switch then results in no further control commands being transmitted for controlling the movement of the machine part. This is therefore a type of dead-man's switch.

According to another embodiment of the invention, latching switches are provided on the hand-held unit for user input, by means of which the user can activate the motion control mode by an active switchover operation on one such latching switch.

An output perceptible to the user of the hand-held unit improves the intuitive, remotely controlled operation of a machine. Acoustic and/or haptic signals in particular can assist the user in an intuitive manner in operating the machine by movements of the hand-held unit. The output performs a form of feedback to the user, so that the human-machine interface can be optimised.

It is proposed for this purpose in particular that the output means are configured such that the output perceptible to the user is generated on the basis of signals output by the motion sensor.

The output means can be configured such that the output perceptible to the user is generated in a graduated manner on the basis of reaching particular signal strengths output by the motion sensor. It is thereby possible, for example, to indicate when the reference position is left and, on reaching a particular relative spatial position, to give a further signal which is used to indicate that a first movement level or control level has been reached. A further signal could be output, for example, when an extreme value of possible movement is reached.

Alternatively, the output means can be configured such that the output perceptible to the user is generated such that it is proportional to the signal strength output

by the motion sensor. It is envisaged here in particular that starting from a reference position, an increasing inclination or tilting in one direction is represented by an increasing acoustic and/or haptic signal, so that the user can find out and assess from this output in what current position the user is holding the hand-held unit relative to the detected or predetermined reference position.

The output perceptible to the user can be generated according to a predefined characteristic on the basis of the signal strength output by the motion sensor. The characteristic curve can be optimised according to the type of control system, so that the dependency of the output, perceptible to the user, on the signal strength output by the motion sensor is directly proportional, i.e. linear, or regressive or progressive. In particular, a logarithmic characteristic is also possible.

According to a preferred embodiment of the invention, the output perceptible to the user from the at least one output means takes place differentially, i.e. only when the signal strength output by the motion sensor changes. A differential or dynamic output of this type normally provides the user with a sufficient subjective feedback sensation from the radio remote control system, and on average places a relatively low load on the power supply of the hand-held unit, because during the periods of constant signal output from the motion sensor, the output means does not need to be active. According to a variant of the invention, it is provided that in regard to generating the output perceptible to the user, it is possible to switch between above-mentioned operating modes, thus for example between a differential mode and a static-proportional mode.

The control unit is preferably configured such that movements detected by the or by a motion sensor in a rotational or tilting working range of at most approximately -45° to +45°, in particular -30° to +30°, about an associated horizontal rotation axis or tilt axis, are converted into control commands for the machine. This limiting of the range of movement that can be converted into control commands for the machine helps ergonomic handling of the hand-held unit, because it is uncomfortable for the human hand to make movements in a larger angular range. In addition, an angular range defined in this way can also serve to fix positions of

the hand-held unit in which the controlling movement by the hand-held unit is disabled, and no further control commands are sent to the machine as a result of detected movements. It is proposed in particular for this purpose that the output means are configured such that they indicate by a suitable output perceptible to the user that the maximum rotational or tilting movement is being approached and/or that the rotational or tilting working range is being left.

As a development, the control unit can be configured such that on leaving the rotational or tilting working range, no further control commands are generated as a result of detected movements until further notice. According to a variant of the invention, however, safety-related control commands, for example stop commands, can be sent from the hand-held unit to the machine if the rotational or tilting working range is left. It is pointed out in this connection that leaving a preferred angular range or range of movement preferably only has an effect on controlling the machine by moving the hand-held unit, but not on controlling the machine by any other control elements on the hand-held unit such as pushbuttons, a joystick or the like. In addition, it is also pointed out that on leaving the rotational or tilting working range, it is defined in the machine control system whether the machine remains in its current state or is taken into a neutral position. In addition, it also needs to be specified whether the movements of all the machine parts that can be controlled by the radio remote control system are meant to be stopped in the event of leaving the rotational or tilting working range, or whether only those drives that are explicitly controlled by the motion control system are stopped. Relevant safety concepts and safety standards can be taken into account in specifying such operating strategies.

According to a preferred development of the invention, the receiver comprises a feedback transmitter and is configured to activate, on receiving control commands, the feedback transmitter to transmit feedback information, the hand-held unit comprising a feedback receiver that is configured to receive the feedback information and is connected to the control unit. The receiver comprising feedback transmitter and the transmitter of the hand-held unit comprising feedback receiver hence form a bidirectional radio remote control system having improved

safety features. The hand-held unit preferably has an acoustic and/or optical and/or haptic indication device which is controlled by the control unit and can be used to indicate operating functional information from the radio remote control system according to the receipt of feedback signals from the feedback transmitter. An indication device of this type is therefore an output means that can inform the user about faults. The aspect of radio feedback, in particular in combination with the aforementioned indication device and the features of the preamble of claim 1, may be of inventive importance in its own right, and the applicant reserves the right to prepare a corresponding independent claim.

A further advantageous aspect of the invention is provided by the features of claim 5, namely that a sensor device that acquires data about the respective actual position of the movable machine part and/or about the state of motion of said part, and a feedback transmitter transmitting the data from this sensor device as feedback information, are provided on the machine, and that the hand-held unit comprises a feedback receiver that is configured to receive the feedback information and is connected to the control device. The hand-held unit preferably has for this purpose an optical and/or acoustic and/or haptic indication device which is controlled by the control unit and represents the respective actual position and/or the current deviation of the actual position from the setpoint position defined by the instantaneous position of the hand-held unit and/or the velocity of movement of the movable machine part. This indication device can therefore inform the user about the respective position, direction of movement and velocity of movement of the machine part. The indication device preferably comprises a display, for example an LCD display, on which the information can be displayed graphically as images or pictograms or videos and/or numerically as numerals and letters.

On the basis of the actual values acquired in this way, the predetermined reference position in the embodiment of the radio remote control system according to claim 2 can be determined such that it is respectively updated, e.g. during each switch-on procedure of the control means, according to the instantaneous position of the movable machine part. In such an embodiment, the hand-held unit first

retrieves the feedback information from the feedback transmitter on the machine before it sends out new control commands.

In addition, it is provided according to a variant of the radio remote control system according to the invention that the control unit is configured to modify control commands for the machine on the basis of the received feedback information. An example of this might be that as the movable machine part approaches its set-point position, the speed of the machine part is automatically reduced and/or the control characteristic is given a higher resolution in the sense of a more sensitive control system.

Within the scope of the invention, further feedback options can be provided in the radio remote control system according to the invention or in a machine equipped therewith, for example the indication of particular machine responses or particular dynamic movement states of the machine or of the movable machine part which are caused for example by control operations or switching operations from a control source other than the radio remote control system. Thus for example, it may be necessary to control a machine in which the movable machine part can be moved between two opposite end positions, and in which a limit-switch mechanism switches off the machine drive as soon as the movable machine part reaches the end position or approaches this within a short distance. According to a development of the present invention, the approach of the machine part to the end position can also be communicated by radio to the hand-held unit via a feedback signal and routed there to a relevant optical and/or acoustic and/or haptic indicator so that the user is made aware of the relevant machine situation.

A further example of an override feedback of this type is for example a crane or lifting gear having what is known as load swing damping, in which the crane trolley or, if applicable, the crane jib, automatically makes compensating movements in order to counteract unwanted swinging of the load suspended from the crane. Such compensating movements can be indicated on the hand-held unit by means of radio feedback from the crane to the hand-held unit. In this case, particularly a

haptic and/or acoustic indicator on the hand-held unit is advantageous in order to inform the user appropriately.

In the following, the invention is described with reference to the accompanying drawings by way of example and without limitation on the basis of an embodiment.

Fig. 1 is a simplified schematic perspective view of a hand-held unit of a radio remote control system.

Fig. 2 shows in the sub-figures a) and b) different elevation views of the hand-held unit of Fig. 1.

Fig. 3 is a highly simplified diagram of movement positions of a hand-held unit in the case of a control mode.

Fig. 4 shows in the sub-figures a) and b) different movement positions of a hand-held unit of a second control mode.

Fig. 5 is a flow chart of a possible control method.

Fig. 1 is a simplified schematic perspective view of a hand-held unit 10 of a radio remote control system for a machine. A machine is understood as meaning devices which have movable parts, the respective position of which can be changed by an appropriate control. The remote control of cranes, arms of concrete pumps, hydraulically driven loading ramps on goods vehicles and the like are envisaged in particular.

The hand-held unit 10 comprises in its housing 12 at least one sensor, which is not shown in greater detail, by means of which spatial movements of the hand-held unit 10 can be detected. It is envisaged in particular that the motion sensor(s) can detect rotational movements about a rotation axis or inclined axis DA and tilting movements about a tilt axis KA. The movements of the hand-held unit 10

can be detected by suitable angle sensors and position sensors. The position sensors and motion sensors used preferably respond to gravity or the earth's gravitational pull and therefore have an angle-dependent resolution or a maximum signal strength that depends on the rotational or tilting movement of the handheld unit. Depending on the location chosen for fitting the position sensors and motion sensors in the housing 12 of the hand-held unit, the output signal can be a maximum for a deflection about the horizontal and can approach zero when rotating or tilting into the vertical.

The hand-held unit shown here purely by way of example can comprise a type of joystick 14, which can normally be operated by the thumb of one hand of the user in order to control relevant machine parts remotely. In addition, two control buttons 16, 18 are shown, which can be actuated to activate further control options. One of these control buttons 16, 18 can be used, for example, to activate a motion control mode in which movements detected by the motion sensors (not shown) are actually converted into control commands in order to be able to control the machine according to movements which are made. In the form of a flip-flop switching mechanism, this control button can also be assigned to disabling this motion control mode when actuated again. Alternatively, enabling or disabling can be performed by different control buttons. In addition, an emergency stop switch which, however, is not shown in the present example can also be provided on a hand-held unit 10. The hand-held unit shown is purely an example and can be of a different configuration both with regard to its external shape and with regard to further or different control elements.

As shown in Fig. 2, the hand-held unit 10 can be rotated or pivoted about its rotation axis DA (inclined axis), which is indicated by the double-ended arrow. In addition, the hand-held unit 10 (Fig. 2*b)*) can also be tilted or pivoted about its tilt axis KA, which is likewise indicated by the double-ended arrow. The movements about the rotation axis DA or tilt axis KA are detected by the motion sensor(s) and converted into control signals when a motion control mode is accordingly enabled, which signals are transmitted to the machine to be controlled remotely.

According to a variant of the invention, it can be provided that pivoting of the hand-held unit about the rotation axis DA and about the tilt axis KA is detected simultaneously and converted into corresponding control commands by the control unit. In this case, according to a development of this variant, it can be provided that optionally one of these control options can be disabled temporarily by a relevant input at the hand-held unit 10, so that for example as a result of pivoting the hand-held unit about the rotation axis DA, no corresponding control commands are communicated to the machine, and only pivoting about the tilt axis KA is detected and converted for the purpose of control. The same also applies to the opposite case in which pivoting about the tilt axis KA can be switched to be passive as a control instruction, so that then only rotations about the rotation axis DA trigger relevant control commands for the machine. According to a further variant of the invention, these control operating modes can also be selected by active switching-on at the hand-held unit 10, for example by actuating a pushbutton switch. Such pushbutton switches can be provided for example in the lower recessed grips 40, 42, 44 (cf. Fig. *2a).* Other switching elements such as rocker switches, thumbwheel switches etc. can also be provided for selecting relevant control options.

In the case of a crane, it could be envisaged, for example, that the lowering or raising of the crane hook is controlled by the pivoting movement about the rotation axis DA. A tilting movement about the tilt axis KA could be used, for example, to control the movement of the crane trolley along the jib. Of course, other control options are also possible for a crane depending on the configuration of the crane and on the configuration of the radio remote control system and of the associated hand-held unit.

Even if it is assumed in Fig. 1 and 2 that rotational and tilting movements about two mutually orthogonal axes can be detected, it is quite conceivable that in a simpler version, the associated motion sensors can only detect movements about one of the axes DA or KA. In such a case, it would be possible, for example, that tilting the hand-held unit 10 about the tilt axis KA causes rotation of the crane

about its rotation axis, and that raising or lowering the crane hook and moving the crane trolley is performed by operating the joystick 14.

Fig. 3 shows, as a schematic rectangular representation, different movement positions of the hand-held unit 10 about its rotation axis DA. In a first control mode or in a first type of control, a current spatial position I of the hand-held unit 10 can be adopted as a reference position. As shown in Fig. 3, this reference position I is slightly inclined with respect to a horizontal in this example. A comfortable pose for such a hand-held unit usually lies in an angular range of +/-20° about the horizontal. In the example of Fig. 3, on activating a motion control mode, for example by pressing a control button 16 or 18 (Fig. 1), the current spatial position I of the hand-held unit 10 is detected and adopted as the reference position for the subsequent motion detection. Rotational or pivoting movements of the hand-held unit 10 about the rotation axis DA into movement positions II or III can then be evaluated in relation to the reference position I and converted into control commands which are transmitted to the machine to be controlled remotely. The movement position IV illustrates a position of the hand-held unit 10 in which a maximum angle of rotation in relation to the reference position I has been exceeded. If the hand-held unit 10 is brought from the reference position or a movement position II or III into such a movement position IV, generation of control commands on the basis of the detected movements can be suspended (termination of motion control mode). A movement position IV may be reached, for example, if a user who is holding the hand-held unit 10 in the hand with the arm bent, then stretches the arm downwards so that the hand-held unit is directed substantially vertically towards the ground.

Fig. 4 shows in the sub-figures a) and b) a different type of control or a different control mode. Assuming that the motion control mode is activated starting from a movement position IV, the hand-held unit must initially be brought into a movement position II or II', which corresponds approximately to a preset reference position I of the hand-held unit 10. Thus, as soon as the hand-held unit 10 reaches a position that corresponds to the movement position II', for example, the movements of the hand-held unit which are then detected are again converted into

control commands which can be communicated to the machine. This is indicated in Fig. 2*b)* by the movement positions III and V. The motion control mode can be disabled, so that the detected movements are no longer converted into control commands, by actuating a control button 16, 18 on the hand-held unit 10, or, as described above with reference to Fig. 3, by leaving a defined angular range and bringing the hand-held unit into the movement position IV, for example.

Fig. 5 shows a simplified flowchart for a type of control according to Fig. 3 in which a current spatial position is determined as the reference position. In a first step 20, a control unit, which is normally accommodated in the housing 12 of the hand-held unit 10, detects whether the motion control mode is enabled, for example by pressing the control buttons 16, 18. After enabling the motion control mode, which is used to convert detected movements into control commands and to communicate these control commands to the machine, the current spatial position (cf. I in Fig. 3) of the hand-held unit is determined as the reference position (step 22). Then, in step 24, the current position is detected and related to the reference position I. Step 26 involves a question as to whether the motion control mode has been disabled. If this is not the case (N), a check is made in step 28 as to whether the hand-held unit has been moved within a preset rotation/tilt range. If the rotation/tilt range has been left (N), the motion control mode is disabled in step 34, and, if applicable, a signal perceptible to the user is generated at the hand-held unit 10. If the movement lies within the rotation/tilt range (J) in step 28, a control command calculated according to the detected movement is generated in step 30 and communicated to the machine to be controlled remotely or to a machine component to be driven. While the motion control mode is enabled, steps 24 to 30 are normally repeated successively in order to be able to detect continuously changing movement positions of the hand-held unit 10 and to be able to generate corresponding control commands. This loop is indicated by the arrow 31.

The hand-held unit preferably also comprises an output means (not shown in the drawings), which is configured such that it generates at least one output perceptible to the user, in particular an optical and/or acoustic and/or haptic signal at the

hand-held unit in response to detected movements. This is carried out for example in step 32. This step 32 extends the repeated loop comprising steps 24 to 32, which is indicated by the dashed arrows 33 bypassing the arrow 31. By generating a signal perceptible to the user, it is possible during the rotational or tilting movement of the hand-held unit 10 producing an angular deflection and during the control command generated thereby, to give a feedback to the user that is perceptible using the senses of hearing, touch or vision, which feedback gives a control confidence that can be experienced subjectively by the user, as the user is familiar with or previously accustomed to, for example, from remote control using a joystick or pushbuttons or the like. Generating a signal perceptible to the user can be specified, for example, on leaving the reference position and on reaching a first level, which, for example, corresponds to a velocity of the machine part to be controlled remotely. When this first level is reached and a further tilting or rotational movement of the hand-held unit is made, a second level of a speed control means (rapid speed), for example, can be reached, which is perceptible to the user by a different signal, in particular by a signal which can be experienced more intensely. If the speed leaves speed level II again and returns to level I, this can likewise be made perceptible to the user by a suitable signal. If the signal perceptible to the user is in the form of a haptic and/or acoustic signal, the user can concentrate visually on the remotely controlled components of the machine while remotely controlling the machine, and need not be forced to look at the hand-held unit 10. The movements which the user performs with the hand-held unit 10 are made perceptible to the user by acoustic and/or haptic signals in a form of feedback, so that the user can perform further movements or countermovements with the hand-held unit 10 according to the perceived signals in order to be able to perform the desired remote control of the machine.

In addition to the above-mentioned example of the output of signals perceptible to the user on reaching particular levels, such signals can also be output in proportion to the detected movements. It is thereby conceivable, for example, to make it possible to experience acoustically/haptically the increase or reduction in the detected angle of rotation or tilt, where it is quite possible that for the increase in the angle, a different signal is output than for the reduction in the angle. If the

hand-held unit is held such that it is motionless in a particular angular position, the relevant signal is not output, and it is not output again until the hand-held unit is moved. Alternatively, it is possible that an acoustic and/or haptic signal is output constantly during the entire motion control mode and preferably is also configured to be proportional to the detected angle of rotation or tilt. For example it is thus possible that a user senses only a weak vibration when holding the hand-held unit in or close to the reference position. During a rotational or tilting movement of the hand-held unit, the vibration increases with increasing pivoting of the hand-held unit, so that the user can detect haptically the movement away from the reference position. Of course, this signalling can also be carried out acoustically.

The proportional output of a signal perceptible to the user is here not limited to a directly proportional dependency between detected movement and signal strength. Instead, a logarithmic signal distribution is also envisaged, which is better suited to human sensation. Both the acoustic and the haptic or vibrational feedback signal (signal perceptible to the user) can be composed, for example, of vibration pulses or of short-burst chains of vibration pulses, the gap between which would decrease with increasing angle of rotation or tilt, and hence the sensed intensity thereof would increase.

An acoustic and/or haptic and/or optical output at the hand-held unit can also be output when the reference position is reached or when a switch-off situation is reached, for example on reaching angles of approximately +/-**45**° relative to the reference position.

According to an extended variant of the invention (not shown in the drawings), the hand-held unit 10 contains a feedback receiver which is configured to receive feedback information from the machine to be controlled, where it is assumed in this case that a feedback transmitter transmitting such feedback information is provided on the machine. In the simplest case, the receiver on the machine can comprise a feedback transmitter which acknowledges the receipt of control commands, and therefore the feedback information involves confirmations of the receipt of control commands. If these expected radio received confirmations are not

registered by the hand-held unit 10, a relevant output means of the hand-held unit 10 can notify the user of a possible fault.

In a further development level of the radio remote control system according to the invention, said system comprises a sensor device that acquires data about the respective actual position of the movable machine part and/or about the state of motion of said part, and a feedback transmitter on the machine transmitting the data from this sensor device as feedback information, the feedback receiver of the hand-held unit being able to receive this feedback information and to pass it to the control unit. According to a variant of the invention, the control unit can then modify control commands for the machine according to the received feedback information. The output means in the form of an indication device can also be configured such that it represents the respective actual position and/or the current deviation of the actual position from the setpoint position defined by the instantaneous position of the hand-held unit and/or the velocity of movement of the movable machine part. An optical and/or acoustic and/or haptic indication or output is also possible in this context.

Patentkrav

1. Radiofjernstyring af en maskine med mindst et ved hjælp af radiofjernstyringen styrbart maskindrev tilhørende en bevægelig maskindel, omfattende
en til maskinen hørende radiomodtagerindretning,
et håndapparat (10) med en styreenhed, en sendeindretning og mindst en bevægelsessensor,
hvorved styreenheden er indrettet til at sende styrekommandoer, som fremkaldes af en bruger, til sendeindretningen, og foranledige sendeindretningen til overføringen af styrekommandoerne til modtageindretningen, og
hvorved ved hjælp af bevægelsessensoren håndapparatets (10) bevægelser i rummet omkring i det mindste en vippe- henholdsvis hældeaksel (KA, DA) er registrerbare på en sådan måde, at de registrerede bevægelser i en bevægelsesdriftsmodus er omformelige til styrekommandoer ved hjælp af styreenheden, hvilke styrekommandoer er indrettet til på maskinen at kunne sendes imellem sendeindretningen og modtageindretningen ved hjælp af radiooverføring, hvorved bevægelsesdriftsmodussen er aktiverbar ved hjælp af en fra brugerens side indgivet indlæsning på håndapparatet (10),
kendetegnet ved, at maskinen er en kran, udligger, læssebro eller et løfteværktøj hver for sig med forskellige bevægelige komponenter, og modtageindretningen omfatter en tilbagemeldingssender - og er indrettet til ved modtagelsen af styrekommandoer at aktivere tilbagemeldingssenderen til sendingen af tilbagemeldingsinformationer, og hvorved håndapparatet omfatter en til modtagelsen af tilbagemeldingsinformationerne indrettet og med styreenheden forbundet tilbagemeldingsmodtager samt en af styreenheden styret akustisk og/eller haptisk viseindretning, ved hjælp af hvilken radiofjernstyringens driftsfunktionsinformationer er viselige efter bestemmelse af modtagelsen af tilbagemeldingssignaler fra tilbagemeldingssenderen.

2. Radiofjernstyring af en maskine ifølge krav 1, **kendetegnet ved,** at styreenheden er således indrettet, at ved aktivering af bevægelsesdriftsmodussen registreres håndapparatets (10) aktuelle position (I) i rummet, som aktuel referenceposition (I), således at bevægelser i forhold til denne aktuelle referenceposition

(I) er registrerbare ved hjælp af bevægelsessensoren og ved hjælp af styreenheden, som styrer kommandoer til maskinen.

3. Radiofjernstyring af en maskine ifølge krav 1, **kendetegnet ved,** at radiofjernstyringen er således indrettet, at ved aktivering af bevægelsesdriftsmodussen registreres håndapparatets (10) aktuelle position (IV) i rummet, og de sammenlignes med en på forhånd givet referenceposition (I), og at registrerede bevægelser først kan sendes som styrekommandoer til maskinen, når radiofjernstyringen i det mindste tilnærmelsesvis ((II, II') er bragt i den på forhånd givne referenceposition (I), hvorved bevægelser i forhold til den på forhånd givne referenceposition registreres til fremstillingen af styrekommandoer.

4. Radiofjernstyring ifølge et af de foregående krav, **kendetegnet ved**, at en sensorindretning, som registrerer data via den respektive bevægelige maskindels øjebliksposition og/eller via dennes bevægelsestilstand - og en tilbagemeldingssender, som sender denne sensorindretnings data som tilbagemeldingsinformationer, er tilvejebragt på maskinen, og at håndapparatet omfatter en tilbagemeldingsmodtager, som er indrettet til modtagelsen af tilbagemeldingsinformationerne og er forbundet med styreindretningen.

5. Radiofjernstyring ifølge et af de foregående krav, **kendetegnet ved,** at styreenheden er indrettet til at modificere styrebefalinger til maskinen i afhængighed af de modtagne tilbagemeldingsinformationer.

6. Radiofjernstyring ifølge krav 4 eller 5, **kendetegnet ved,** at håndapparatet omfatter en viseindretning, som styres af styreenheden, og optisk og/eller akustisk og/eller haptisk viser den respektive øjebliksposition og/eller den aktuelle afvigelse af øjebliksspositionen fra den ved hjælp af håndapparatets momentane position bestemte ønskeposition og/eller den bevægelige maskindels bevægelseshastighed.

7. Radiofjernstyring ifølge et af de foregående krav, **kendetegnet ved,** at den omfatter i det mindste et til håndapparatet (10) hørende outputmiddel, som er

således indrettet, at det som reaktion på registrerede bevægelser af håndapparatet fremstiller i det mindste en for brugeren registrerbar udlevering, især et optisk og/eller akustisk og/eller haptisk signal, til håndapparatet.

8. Radiofjernstyring ifølge krav 7, **kendetegnet ved,** at outputmidlet er således indrettet, at den for brugeren registrerbare udlevering fremstilles i afhængighed af signaler, som udleveres ved hjælp af bevægelsessensoren.

9. Radiofjernstyring ifølge krav 8, **kendetegnet ved,** at outputmidlet er således indrettet, at den for brugeren registrerbare udlevering fremstilles trinagtigt i afhængighed af opnåelsen af bestemte signalstyrker, som udleveres af bevægelsessensoren.

10. Radiofjernstyring ifølge krav 9, **kendetegnet ved,** at outputmidlet er således indrettet, at den for brugeren registrerbare udlevering fremstilles proportionalt med signalstyrker, som udleveres af bevægelsessensoren.

11. Radiofjernstyring ifølge et af de foregående krav, **kendetegnet ved,** at styreenheden er således indrettet, at bevægelserne, som registreres ved hjælp af bevægelsessensoren henholdsvis en bevægelsessensor, omformes i et arbejdsdreje- henholdsvis vippeområde fra maksimalt -45° til +45°, især -30° til +30° omkring en tilhørende vandret dreje- henholdsvis vippeakse i styrekommandoer til maskinen.

12. Radiofjernstyring ifølge krav 11 og et af kravene 7 til 10, **kendetegnet ved,** at outputmidlet er således indrettet, at det viser en tilnærmelse til den maksimale dreje- henholdsvis vippebevægelse og/eller en forladelse af arbejdsdreje- henholdsvis vippeområdet ved hjælp af en tilsvarende for brugeren registrerbar udlevering.

13. Radiofjernstyring ifølge krav 11 elle 12, **kendetegnet ved,** at styreenheden er således indrettet, at ved forladelsen af arbejdsdreje- henholdsvis vippeområdet fremstilles der ingen yderligere styrekommandoer på grund af registrerede bevægelser.

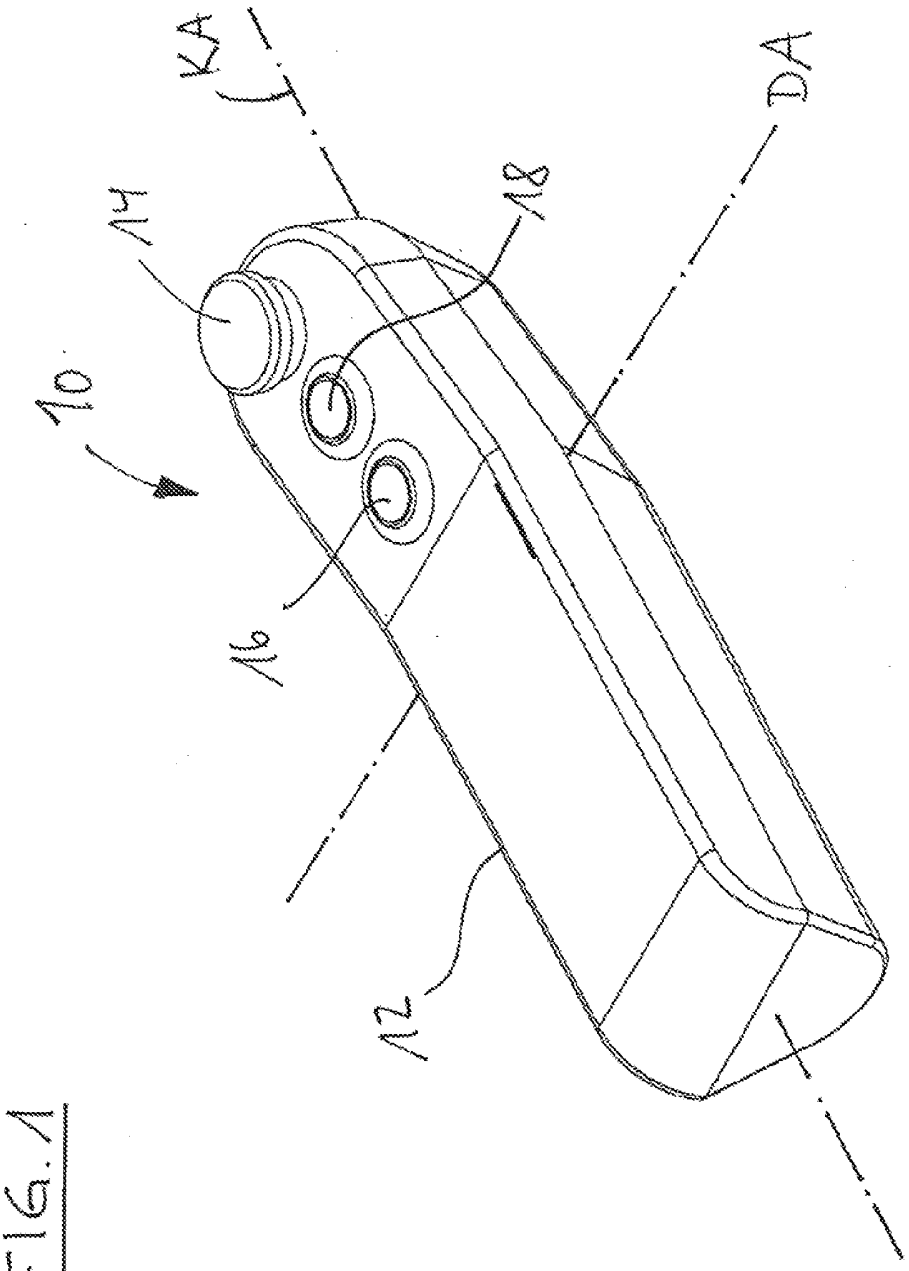


FIG.1

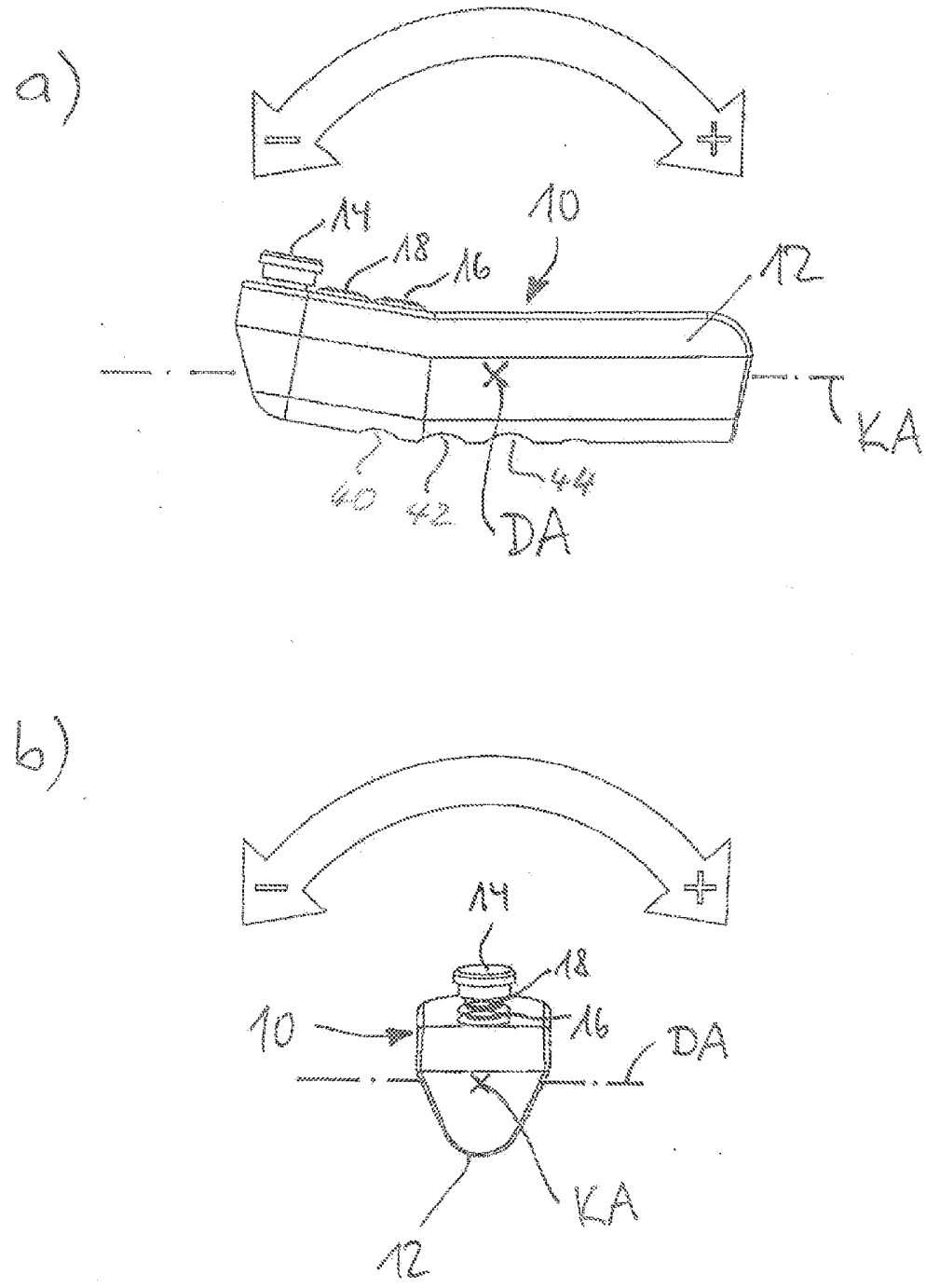


FIG. 2

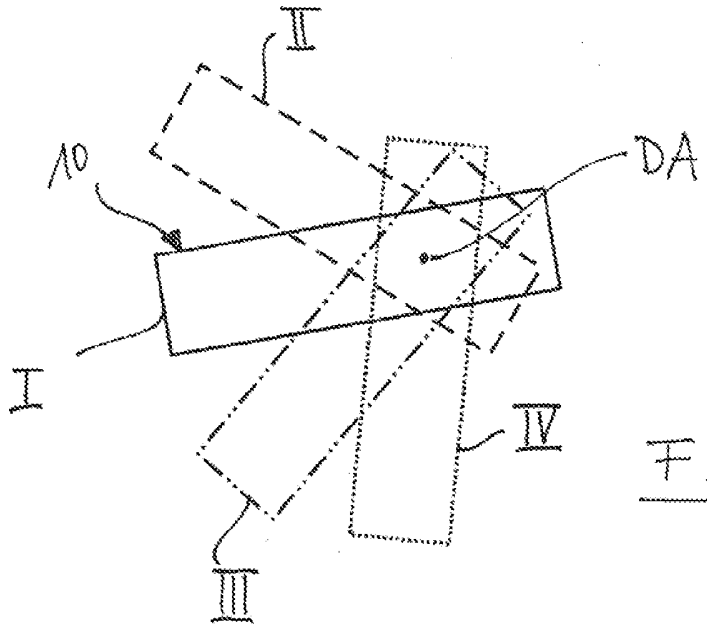


FIG.3

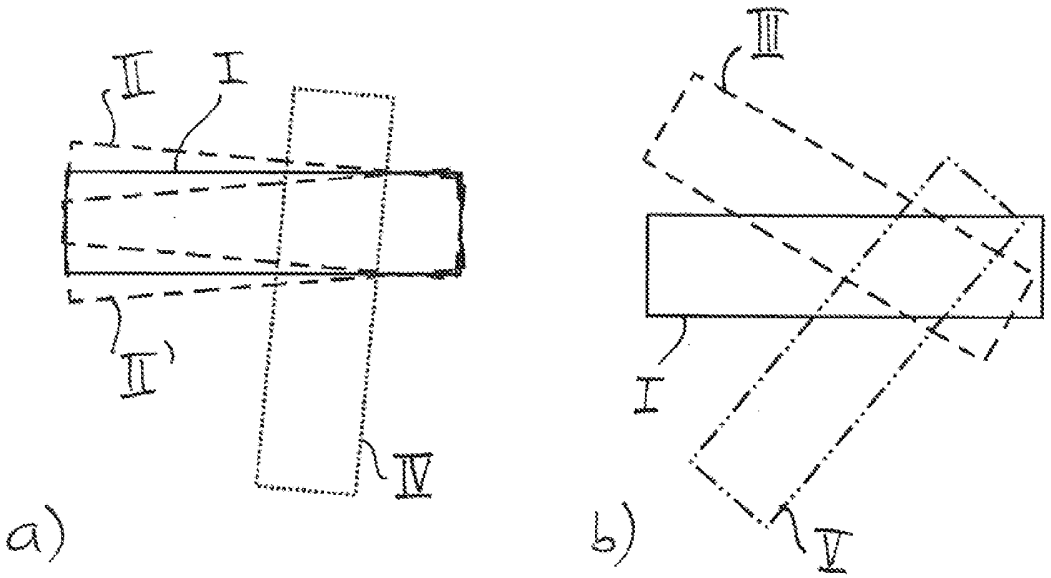
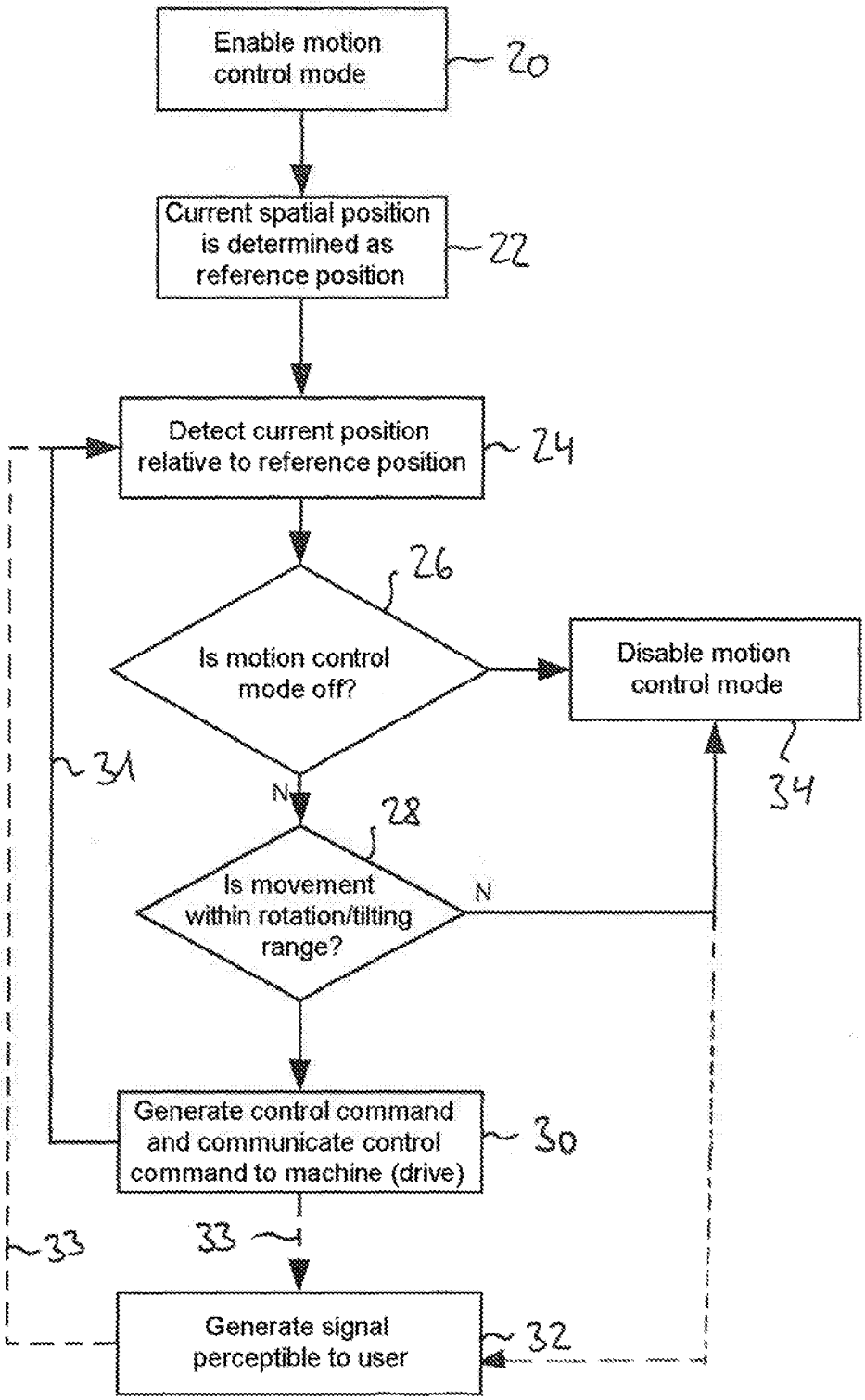


FIG.4

FIG. 5


Enable motion control mode
20
Current spatial position is determined as reference position
22
Detect current position relative to reference position
24
26
Is motion control mode off?
Disable motion control mode
34
31
N
28
Is movement within rotation/tilting range?
N
Generate control command and communicate control command to machine (drive)
30
33
33
Generate signal perceptible to user
32