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(73) Patenthaver: **Diehl Metering Systems GmbH, Donaustrasse 120, 90451 Nürnberg, Tyskland**

(72) Opfinder: **PETKOV, Hristo, Jülicherstr. 7, DE - 90425 Nürnberg, Tyskland**
LAUTENBACHER, Thomas, Breslauer Str. 31, DE - 91058 Erlangen, Tyskland
KAUPPERT, Thomas, Am Waldrand 28, DE - 90455 Nürnberg, Tyskland
Mzyk, Raphael, Steingruberstr. 4, DE-91126 Kammerstein, Tyskland

(74) Fuldmægtig i Danmark: **RWS Group, Europa House, Chiltern Park, Chiltern Hill, Chalfont St Peter, Bucks SL9 9FG, Storbritannien**

(54) Benævnelse: **FREMGANGSMÅDE TIL OVERFØRSEL AF DATA**

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DESCRIPTION

The present invention relates to a method for transmitting data between a terminal and a data collector by radio, according to the preamble of Claim 1.

Technological Background

Terminals of the relevant generic type are intelligent consumer metering devices, for example, also called smart meters. These are consumption meters typically assigned to residential, industrial or commercial units and integrated into a mains supply network, e.g. for heat, electricity, gas, or water. The intelligent consumption meters indicate the actual consumption to the respective connection user and transmit it to a higher-level central unit, e.g. the supplier's central control unit. Therefore, the advantage of intelligent consumption meters is that manually taken meter readings are no longer necessary and that the supplier can invoice customers in a timelier manner in line with their actual consumption. Shorter reading intervals, in turn, allow a more precise coupling between the retail prices and the course of the market electricity prices. Loading on the supply networks can also be much better controlled.

The resulting measurement data from the consumption meters are usually transmitted by radio in the form of data packets or telegrams, for example in the ISM (Industrial, Scientific, Medical) band or SRD (Short Range Devices) band frequency ranges, to higher-level data collectors or concentrators, which store the data and transmit it on to the central control unit. A problem with these frequency ranges is that they are also the frequency ranges commonly used for a wide variety of technical devices, such as garage door controls, baby monitors, alarm systems, WLAN, Bluetooth, smoke detectors or the like, with the result that interference can often occur, reducing the likelihood of successful transmission.

In addition, the energy efficiency of consumption meters of the

generic type is of great importance, since modern consumption meters are usually battery-operated and their maintenance intervals should be as long as possible. Frequent data transmissions as well as increased reception availability times, so-called reception windows, greatly reduce the battery life but improve the transmission quality or transmission reliability, i.e. the probability of a successful transmission of the data. In this case, a compromise is usually chosen in which a just sufficient transmission and reception window with sufficient transmission reliability is chosen, which still appears acceptable from an energy point of view. Accordingly, there is great interest in reducing the energy requirements of the consumption meters and improving transmission reliability.

Prior art documents

A method according to the preamble of Claim 1 is known from US 2014/0028465. In this method, after establishing a communication, the consumption meter sends data in the form of IDM (Interval Data Message) transmissions, variable-length data packets or multiple datagrams comprising separate data packets. The data collector processes the received data and decides whether further bidirectional communication is necessary or not.

Document US 2013/0308685 describes a wireless communication system comprising WLAN and BT, in which BT messages can be transmitted over a plurality of different frequency channels depending on the quality of the WLAN frequency channels, by means of a frequency hopping function.

Document US 2010/76967 A1 discloses a wireless communication method between terminals and a mobile data collector, in which the data collector initially sends T25 ID pilots to the terminal periodically and the latter performs an RSSI test. If the result is positive, the terminal performs a Demand Reset and sends a Data Request packet to the data collector.

US 2012/0059610 A1 describes an energy recording system which

comprises a data collector and individual energy meters that are able to communicate bidirectionally. The data collector collects the readings of the energy meters.

DE 10 2007 062 077 A1 discloses a method for transmitting the measurement data from consumption meters to a data collector by radio, in which the data collector is temporarily or permanently in receive mode and the consumption meter is in an idle phase for the majority of the time, that is, it is not ready to send. The consumption meter periodically switches to transmission readiness and attempts to establish a two-way radio connection with the data collector, wherein the consumption meter transmits a short radio signal on a first channel and then switches to receive mode on a second channel, i.e. it opens a reception window to receive a possible response from the data collector. In the event that the data collector responds, for example, with a confirmation signal, the data are completely or partially transmitted to the data collector on the second channel. After this, or if the transmission is not successful, the consumption meter returns to the idle phase. This is designed to ensure a successful transmission from the consumption meter to the data collector. In this case, radio signals from multiple metering devices can overlap if they are sent to the data collector simultaneously. In addition, the transmission conditions at the location of a communication node can change abruptly, for example, by the appearance of an interfering device (e.g. another device transmitting on the respective frequency channel), with the result that even after successful communication has been set up no successful data transmission can take place, thereby reducing the transmission quality and transmission reliability. Instead, all data transmission must be repeated, which has a significant negative impact on the energy requirements.

Object of the present invention

The object of the present invention is therefore to provide a method for transmitting data, in which the energy requirement

for data transmission is reduced and the transmission reliability and transmission quality of the data are improved.

Achievement of the object

The above object is achieved by the entire teaching of the claim. Advantageous designs of the invention are claimed in the sub-claims.

In the method of the generic type for transferring data between a terminal, which according to the invention is a consumption meter or a sensor, and a data collector by radio, the data collector is usually temporarily or permanently in receive mode, wherein from an idle phase (e.g. standby mode) the terminal attempts to establish communication with the data collector to completely or partially transmit the data to the data collector and/or to receive data from the data collector. For example, the idle phase can be a period of time during which the terminal records the current readings, e.g. the current amount consumed, but the readiness to transmit and/or receive is switched off, or at least restricted, in order to reduce the energy consumption. Alternatively, the data collector can also attempt to establish communication with the terminal via at least one frequency channel, in order to completely or partially transmit the data to the terminal and/or receive data from the terminal. In this case, the terminal device exits the idle phase at periodic intervals of time and switches to receive mode for a specified period of time.

According to the invention, after communication has been established and thus during communication, i.e. the transmission of the data, the terminal sends at least one message to the data collector. For example, this message can also be sent repeatedly. After receiving the message, the data collector can continue, interrupt and/or terminate the transmission of the data based on the content of the message. This results in the advantage that the duty cycle can be reduced. The fact that the terminal requests the transmission of the data from the data collector

via the message means that the terminal can remain in the energy-saving idle phase for longer periods. This results in the advantage that the active transmission times of the terminal can be adapted to the respective transmission situation. For example, the data transmission of the data collector can be interrupted or aborted by the terminal if the frequency channel is subject to interference or is occupied, i.e. if it is likely that successful data transmission will not be possible. The energy consumption can thus be improved considerably, as unnecessary ready-to-receive times are reduced or even prevented, which can significantly extend the lifetime of the energy supply. In addition, the available transmission time (duty cycle) of the data collector can be adjusted in such a way that it preferably only transmits when the probability of a successful data transmission is sufficiently high. Furthermore, the transmission reliability and the transmission quality of the data can be increased considerably by the application of the method, by only transferring data, for example, when good transmission conditions exist in the region of both communication nodes for preferably the entire duration of the data transmission.

Advantageously, the terminal can transmit a radio call from the idle phase at periodic intervals and then switch to receive mode for a specified period of time to establish the, in particular bidirectional, communication with the data collector. The radio call can be e.g. a beacon, a message, a data packet, a partial data block, a synchronization signal, or the like. Alternatively or in addition, the data collector can also send a radio call to establish communication with the terminal, wherein the terminal device switches from the idle phase to receive mode at periodic intervals in order to receive the radio call. Accordingly, either the data collector (“pull” mode) or the terminal (“push” mode) can initiate the establishment of the communication.

According to the invention, the data are transmitted over at least one frequency channel and in the form of data packets, each comprising a plurality of data blocks, which in turn can

be divided into partial data blocks (so-called "hops"). For example, a number of partial data blocks form a 4-, 16-, or 32-byte data block.

In addition, in the event that the data collector has received the radio call from the terminal, the data collector can either send the data to the terminal so that the latter can receive the data, or send a confirmation signal to the terminal, wherein after receiving the confirmation the terminal can completely or partially transmit the data to the data collector so that the data collector receives the data, i.e. a bidirectional communication takes place in which the participating communication nodes must confirm the impending data transmission to each other either by the data collector sending the data or by means of a confirmation signal ("handshake"). Transmission reliability can thus be improved significantly.

In the same manner, if the data collector has received the radio call from the terminal, the data collector can abort the transmission of the data and/or send a confirmation signal to the terminal to abort the transmission of the data.

Preferably, the terminal sends the message at definable time intervals. The time intervals can be defined in advance, in a random or pseudo-random manner.

The advantage obtained by the terminal sending the message before and/or after one or more data blocks or partial data blocks and/or pilot sequences is that the transmission of the data can be aborted individually by the terminal and/or the data collector, e.g. after a specifiable partial data block, if the transmission quality is not good enough, for example.

According to the invention, the data are transmitted on a plurality of frequency channels (K1-K6). This can improve the transmission reliability and transmission quality of the data even further.

According to the invention, the data blocks or partial data blocks are transmitted on multiple frequencies or frequency channels in the so-called frequency hopping method, in order to improve the transmission quality of the data. Frequency channels can preferably be systematically selected in order, for example, to block out frequency channels subject to interference and to transmit via interference-free or lower-interference frequency channels.

According to a preferred design of the present invention, the terminal and/or the data collector can carry out an assessment of the transmission quality or transmission reliability of the frequency channel or frequency channels. For example, the assessment can be based on interference detection, the signal level (signal power, signal strength), the signal-to-noise ratio, the signal-to-interference ratio, a probability ratio (LLR value; log likelihood ratio), or the like. These allow a simple means of determining the transmission quality.

Preferably, the assessment of the transmission quality can be carried out in such a way that the receiving channel is checked for hidden nodes (a so-**called "hidden node detection"). Data** transmission can be aborted or interrupted in a preferred manner if signals or transmissions of hidden nodes are found on the receiving channel, which affect the transmission quality, for example.

It is particularly advantageous if the message is generated based on the determined transmission quality of the respective frequency channel. This results in the advantage that the transmission quality of the respective frequency channel is used in order to continue, interrupt and/or terminate a transmission of the data. For example, this criterion can be used to abort a data transfer whenever sufficient transmission quality is no longer available.

According to the invention, the message comprises a start/stop information item or a start/stop signal to inform the data

collector and/or the terminal that the transmission of the data should be continued, interrupted and/or terminated.

Alternatively or in addition, the message may also comprise ACK (acknowledgement)/NACK (no acknowledgement/negative acknowledgement) information, which is designed to inform the data collector and/or the terminal which data blocks and/or partial data blocks have been successfully transmitted.

The data collector and/or the terminal can then send the data that were not successfully transmitted repeatedly or multiple times until they have been successfully transmitted. This significantly improves transmission reliability and transmission quality.

A synchronization sequence for time synchronization and/or frequency synchronization of the terminal can be advantageously provided, which can be used for synchronizing the time or frequency reference device of the terminal.

According to a preferred design variant of the invention, pilot sequences are assigned to a definable number of data blocks and/or partial data blocks, such as a preamble, postamble and/or inter- or midamble, i.e., for example, a bit string that is prepended to, appended to or placed in between the data blocks or partial data blocks and is recognized by the receiver as a signal.

The pilot sequences are preferably part of the synchronization sequence. For example, a time synchronization of the time reference devices can be carried out via a specific chronological sequence of the pilot sequences.

Advantageously, the terminal can also send the message on a first frequency channel and then be ready to receive it on a second frequency channel in order to receive the response of the data collector, such as a transmission of the data by the data collector, via the second frequency channel. This can also

result in a random or pseudo-random change of the frequency channels ("ping-pong"), which makes a possible attack by third parties more difficult and thus improves data security.

The radio connection between the terminal and the data collector can be, in particular, a bidirectional radio connection, in which, for example, all communication nodes can send and receive data, signals, radio calls or the like.

Preferably, the receiving bandwidth of the receiver unit (e.g. of the terminal and/or the data collector) is in the narrow-band range. According to a preferred design, the receiving bandwidth of the respective receiver unit is less than 25 kHz, preferably less than 20 kHz, preferably less than 5 kHz, preferably less than 3 kHz, particularly preferably less than 2 kHz. The bandwidth can be determined in particular according to the standard ETSI EN 300 220-1 V3.1.1 (as of 02/2017).

The terminal device is advantageously a water, heat, gas or electricity meter, or other consumption meter known from the prior art. In addition, sensor nodes can also be provided to measure the consumption of space, or volume or level. These can be, for example, level meters for refuse bins or other storage devices.

According to a preferred design of the invention, a plurality of terminals and/or data collectors are provided that communicate with each other within a communication system.

Preferably, the data rate in the uplink, i.e. from the terminal to the data collector, is higher than the data rate in the downlink, i.e. from the data collector to the terminal, by at least a factor of 3, preferably a factor of 4, particularly preferably a factor of 5.

According to a particular design, the data rate can be varied within a data block and/or a partial data block. This results in the advantage that the data rate or data flow within a data

packet can be controlled, so that the data rate can be adapted to the respective transmission situation quickly, individually and even during data transmission, thereby improving the transmission quality and transmission reliability to a considerable extent.

At least one transmission pause may also be provided between the transmissions of the data blocks and/or partial data blocks.

The duration of the transmission pause is preferably set such that it has at least the same length as the transmission of the data block or the partial data block, in particular in the uplink.

Advantageously, after receiving the message from the terminal, the data collector can therefore slow down or speed up the transmission of the data during communication based on the content of the message, e.g. by increasing or decreasing the duration of the transmission pauses and/or by decreasing or increasing the data rate.

In an advantageous design, after the data transmission has been aborted and/or interrupted, a period until the transmission is repeated and/or continued can be defined. This allows the transmission of the data to be postponed until a later time. In a simple way, the period can be defined by the sending and/or receiving unit, i.e. the terminal and/or the data collector, after which the specified period of the respective other unit (terminal or data collector) is transmitted and, if necessary, confirmed again by the latter unit.

In addition, the communication quality between the data collector and the terminal can be provided as a criterion for sending the uplink message from the terminal to the data collector. For example, the terminal can send the message to indicate that the downlink communication between the data collector and the terminal, or the reception by the terminal, is poor, impaired or suboptimal.

According to a particular configuration of the method, the status of the energy supply for the terminal can be provided as a criterion for sending the uplink message from the terminal to the data collector. This means that the terminal can send a message to the data collector, for example, in order to inform the data collector of the status of the energy supply for the terminal, for example, that the energy supply or the energy buffer has a low voltage. This can also be used to indicate, for example, an imminent replacement of the energy supply or the terminal.

In the method for transmitting data between a terminal and a data collector by radio, the data collector is temporarily or permanently in receive mode. The terminal attempts to establish communication with the data collector from an idle phase at periodic intervals in order to completely or partially transmit the data to the data collector or to receive data from the data collector. For example, for this purpose the terminal can send a radio call to the data collector from the idle phase and then switch to receive mode for a definable period of time in order to establish communication with the data collector. Alternatively, the terminal can also switch from the idle phase to receive mode for a definable period of time, wherein the data collector sends a radio call to the terminal, for example, within this time period known to it, in order to establish communication with the terminal. In the event that the respective receiver receives the message, it can send the data or a confirmation signal to the sender of the message in order then to completely or partially transmit the data, i.e. send it to the data collector or the terminal. According to the invention, an assessment of the transmission quality of the respective frequency channel is carried out, wherein on the basis of the transmission quality of the respective frequency channel a decision is made as to whether or not the data transmission should take place via this frequency channel. This results in the advantage that, for example, the data collector can adapt the transmission of the data to the transmission qualities of the respective frequency channels. In addition, certain terminal

devices could also be prioritized, for example, if the last data transmission is further in the past or if it is a terminal that regularly has poor transmission quality or is difficult to reach. This significantly improves the transmission reliability and the transmission quality.

The transmission quality is preferably assessed on the basis of the signal power and/or the average signal power and/or the variation in the signal power on the respective frequency channel. For example, the transmission quality can be determined on the basis of an interference source measurement, wherein for the interference source measurement the signal power (of the data transmission) is measured against the power of the interference source, or compared with the latter.

Description of the invention based on exemplary embodiments

Advantageous designs of the present invention will now be explained in more detail by reference to the figures of the drawing. In the drawings:

Fig. 1 shows a simplified, schematic representation of an application example of the method according to the invention;

Fig. 2 shows a simplified, schematic representation of a data transmission comprising a plurality of data packets;

Fig. 3 shows a simplified, schematic representation of a data transmission with a plurality of data packets and assigned pilot sequences;

Fig. 4 shows a simplified, schematic representation of a configuration of a data transmission preceded by a detection of hidden nodes;

Fig. 5 shows a simplified, schematic representation of a further configuration of a data transmission;

Fig. 6 shows a simplified, schematic representation of a transmission sequence between a consumption meter and a data collector, and

Fig. 7 shows a simplified, schematic representation of a frequency channel pattern.

Fig. 1 shows a plurality of terminals, which are implemented as consumption meters 1, and a data collector 2 or data concentrator, wherein a bidirectional transmission of data, e.g. consumption, programming or operating data, is carried out between the consumption meters 1 and the data collector 2 by radio using the method according to the invention. The transmission of the data is therefore a data transmission in which the communication nodes, such as the consumption meter 1 and the data collector 2, can be both sender and receiver. The data can be transmitted via the ISM and/or SRD frequency bands, for example.

The consumption meters 1 in Fig. 1 are configured as fluid meters (e.g. water, gas or heat meters), each comprising an electronics housing 3 for receiving the electronic components, which for the sake of clarity are not shown in Fig. 1, such as a control and evaluation unit and a microcontroller and a communication module, or communication device. In addition, an energy supply 3a, such as a battery or an accumulator, is provided for supplying energy to the consumption meter 1. Such a consumption meter 1 also comprises a connection housing 4 for connecting the consumption meter 1 to a mains supply network, also not shown, such as the drinking water supply for a household. In addition, the consumption meters 1 each comprise a means of determining consumption (also not shown in Fig. 1), on the basis of which the consumption of a supply medium is determined. For example, this may be an ultrasonic transducer arrangement, in which ultrasound signals are sent along a measurement path located between two ultrasonic transducers in and against the flow direction of the fluid (e.g. water). From the difference in the propagation times of the ultrasonic signals in and against the flow direction of the medium, it is possible, for example, to

determine the volumetric flow and therefore the consumption. The measured consumption can then be transmitted to the data collector 2 via an antenna of the communication device. In addition, a display device, e.g. a display 5, is provided on the consumption meter 1 for displaying the current consumption values or the meter reading.

In addition, the consumption meters 1 each comprise a time and/or frequency reference device (also not shown), which are designed to specify and/or set the time and/or frequency. A vibrating quartz crystal, for example, with a certain error deviation (e.g. 5 ppm) is used as a reference device. Due to the error deviation, it is sometimes necessary to synchronize the reference devices, e.g. with the data collector 2, to ensure that both the transmitter and receiver use the clock time or frequency (or frequency channel) specified for the data transmission.

The data collector 2 comprises a housing 6, a communication module 7 with antenna 8, in particular for transmitting the data, and a data memory 9a for collecting or storing the data. The data collector 2 can transmit the data to a higher-level central control unit, for example, not shown in the figures, such as the provider's central control unit, by wireless or wired means. In addition, the data collector 2 comprises an energy supply 9b. This can be a mains connection or an energy storage device, such as a battery or an accumulator.

The data collector 2 is temporarily or permanently in receive mode for receiving the data from a consumption meter 1 or the central control unit. On the other hand, the respective consumption meter 1 is usually in an idle phase, in which the consumption meter 1 determines and, if necessary, stores the current consumption, but is preferably not ready to transmit and/or receive, in order to save energy. In the event that the consumption meter 1 wants to send data or is ready to receive data from the data collector 2, such as software data of a firmware update, the consumption meter 1 can attempt to **establish communication with the data collector 2 (“PUSH mode”),**

for example. For this purpose, the consumption meter 1 can send out a radio call at definable intervals of time from the idle phase and then switch to receive mode for a definable period of time to establish communication with the data collector 2, i.e. open a reception window, to receive the response from the data collector 2, or the data or a confirmation signal for sending the data by means of the consumption meter 1. For example, a short signal or a portion of the data (such as data blocks, partial data blocks or just bits thereof) can be provided as a radio call. Alternatively, however, the data collector 2 can also attempt to initiate communication with the consumption meter 1 (“PULL mode”) by the data collector 2 sending out a radio call and the consumption meter 1 changing from the idle phase into receive mode for a specified period of time at definable intervals of time. During this reception time, the consumption meter 1 can receive the radio call from the data collector 2 in order to establish communication between consumption meter 1 and data collector 2. A beacon can also be provided as the radio call, instead of or in addition to the variants described above.

Advantageously, in the event that it has received the call from the consumption meter 1, the data collector 2 can send the data to the consumption meter 1. In addition, the data collector 2 can also send a confirmation signal to the consumption meter 1 and thus signal to the consumption meter 1 that it should completely or partially transmit the data to the data collector 2, so that the latter receives the data or that it returns to the idle phase.

Fig. 2 shows a representation of a data transmission 10, which comprises a plurality of data packets 11, each of which is divided into data blocks 12 which are in turn divided into partial data blocks 13. For example, a data packet can contain 192 bytes, a data block 32 bytes, and a partial data block 4 bytes. The entire data transmission 10 can be transmitted piece by piece. At least one definable number of data blocks 12 and/or partial data blocks 13 can also comprise a pilot sequence 14,

as shown in Fig. 3. For example, the pilot sequence 14 can be a pre-, inter- (or mid-) and/or post-amble that is prepended, interspersed and/or appended to the respective data blocks 12 and/or partial data blocks 13 as a part of the respective block or as a hop or bit sequence.

The pilot sequences 14 of multiple data blocks 12 or partial data blocks 13 can function as a synchronization sequence for the synchronization of the time and/or frequency reference devices of the consumption meters 1, for example, because the pilot sequences 14 have a defined time interval between one another, which is known to all communication nodes and from which the time deviation can be determined.

The data transmission preferably takes place in the narrow-band region, i.e. the receiving bandwidth of the respective consumption meter 1 is preferably less than 25 kHz, preferably less than 20 kHz, preferably less than 5 kHz, preferably less than 3 kHz, particularly preferably less than 2 kHz. The bandwidth can be determined, for example, according to the standard ETSI EN 300 220-1 V3.1.1 (as of 02/2017). Normally, such a receiving bandwidth would require longer periods in which the consumption meters 1 are ready to receive, i.e. the respective consumption meter 1 would have to be ready to receive for a relatively long time in order to receive the data, which would significantly increase the energy consumption. This means that the energy of the consumption meter 1 is additionally consumed if, for example, the relevant frequency channel is currently occupied or subject to interference. In addition, for example, the available transmission time, i.e. the duty cycle, of the data collector 2 is wasted by the data collector sending data even though the data cannot be received by the consumption meter 1.

By using the present method this problem can be avoided, e.g. by the consumption meter 1 signalling and/or confirming the transmission of the data to the data collector 2 via a feedback or a message 15 during communication, and thus controlling the

data transmission. For this purpose, the consumption meter 1 sends the message 15 to the data collector 2 at preferably definable intervals of time during the communication, allowing the consumption meter 1 to inform the data collector 2 of whether the transmission of the data should be continued, interrupted and/or terminated, and providing a kind of data flow control by the consumption meter 1 or the receiver. For example, the consumption meter 1 can use this to abort the data transmission.

A transmission of the data can take place, for example, by first performing a hidden node detection before the first data blocks 12, partial data blocks 13 or their pilot sequences 14 are sent by the consumption meter 1, as shown in Fig. 4. The average signal level and the variation of the signal power on a particular frequency channel are known to the data collector 2 or are determined by this and/or the consumption meter 1. For example, this can be achieved by an assessment of the transmission quality of the respective frequency channel on the basis of the last transmitted data blocks 12 or partial data blocks 13 and of statistics derived from them. For example, if the signal level on the respective frequency channel exceeds a definable limit, i.e. has poor transmission quality, the corresponding frequency channel is devalued.

The poor transmission quality can be caused, for example, by interfering devices, transmitters or nodes (hidden nodes) that are transmitting on the same frequency channel and cannot be identified by the consumption meter 1 or by the data collector 2.

This can also be, for example, another consumption meter 1 which wants to transmit data to the data collector 2. The data transmission in this case is aborted and/or postponed to a later time. For this purpose, the consumption meter 1 sends a message 15 in the uplink to interrupt or terminate the data transmission, e.g. with the information **or content “Stop”, to the data** collector 2, or the data collector 2 sends a message 15 to the consumption meter 1 in the downlink to interrupt or terminate

the data transmission, e.g. with the information or the content "Stop". If the signal level is below the limit value, i.e. the transmission quality on the frequency channel has been assessed as good, the next frequency channel is preferably checked, e.g. by means of the pilot sequences 14 ("synchronization hops") of the first data block 12. If the data blocks 12 or partial data blocks 13 are not transmitted or only partially transmitted, the consumption meter 1 or data collector 2 sends a "Stop" message once again to interrupt or terminate the data transmission to the data collector 2 or the consumption meter 1, whereupon the data transmission from the respective receiver and/or transmitter is interrupted or terminated. By contrast, to confirm or start the data transmission the consumption meter 1 (or the data collector 2) sends a message 15 with the information "Start" or "Continue" to the data collector 2 (or the consumption meter 1).

The message 15 can thus comprise a start/stop information item to inform the data collector 2 or the consumption meter 1 that the transmission of the data should be continued, interrupted and/or terminated. Alternatively or in addition, the message 15 comprises an ACK/NACK information item, which is designed to inform the data collector 2 or the consumption meter 1 which data blocks 12 and/or partial data blocks 13 have been successfully transmitted. The data blocks 12 and/or partial data blocks 13 that are not or only partially transmitted can then be sent repeatedly until they have been successfully transmitted and have consequently been confirmed by the receiver to the sender with an ACK information item. For example, the partial data blocks 13a-13d, as shown in Fig. 5, can be sent until they have been fully transmitted.

Fig. 6 shows a configuration of a transmission sequence, in which the consumption meter 1 first sends a radio call to the data collector 2 from the idle phase, in order to request the data for a firmware update, for example. The partial data block 12 which the data collector 2 receives is used as the radio call. After the transmission of the radio call, the consumption meter

1 opens a reception window 18 for receiving a response from the data collector 2. The data collector 2 then responds by sending the partial data block 13a preceded by a pilot sequence 14. The consumption meter 1 receives the partial data block 13a with pilot sequence 14, i.e. the communication is thus already established upon receipt of the pilot sequence 14. Now the consumption meter 1 sends a message 15 to the data collector 2 to inform the data collector 2 that the partial data block 13a was successfully transmitted ("ACK") and the transmission is to be continued ("Start"). After this, the consumption meter 1 opens a reception window 18 again. After receiving the message 15 (ACK/Start), the data collector 2 again responds by sending the partial data block 13b with pilot sequence 14. However, the partial data block 13b is not successfully received by the consumption meter 1, e.g. due to an interference source on the relevant frequency channel, whereupon the consumption meter 1 requests the partial data block 13b again with the message 15 (NACK/Start). Data collector 2 then re-sends the partial data block 13b to the consumption meter 1.

After the consumption meter 1 has again failed to receive the partial data block 13b successfully, the consumption meter 1 aborts the transmission to the data collector 2 with the message 15 (NACK/Stop). It then reverts to the idle phase or standby mode to save energy and to postpone the data transmission to a later time with better transmission conditions, e.g. several milliseconds, seconds, or minutes later. After receiving the message 15 (NACK/Stop), the data collector 2 also terminates the transmission process. The communication between the consumption meter 1 and the data collector 2 is thus terminated. In addition, the consumption meter 1 can use the pilot sequences 14 already received for time and/or frequency synchronization.

According to a preferred design of the invention, the data transmission can also be carried out using a frequency hopping method, in which the data are transmitted optionally via a plurality of different frequency channels K1-K6 in order to increase the probability of a successful transmission. For

example, the data collector 2 can also be informed of a proposed frequency channel change by the consumption meter 1 via the message 15, wherein the data collector 2 in turn confirms the change by a response to the consumption meter 1 in order to implement the frequency channel change. A specific sequence of frequency channels K1-K6, via which each data block 12 and/or partial data block 13 or only bits or bytes thereof are transmitted, is called the frequency channel pattern 17. Fig. 7 shows a design variant of such a frequency channel pattern 17, in which partial data blocks 13 are transmitted over six different frequency channels K1-K6. However, within the scope of the invention, very many more frequency channels K1-Kn and a plurality of frequency channel patterns 17 can also be provided for transmitting the data blocks 12 and/or partial data blocks 13.

The content of the disclosure also explicitly includes individual feature combinations (sub-combinations) as well as possible combinations of individual features of different embodiments that are not represented in the drawing figures.

LIST OF REFERENCE SIGNS

1	consumption meter
2	data collector
3	electronics housing
3a	energy supply
4	connection housing
5	display
6	housing
7	communication module
8	antenna
9a	data memory
9b	energy supply
10	data transmission
11	data packet
12	data block
13	partial data block
13a-13d	partial data block
14	pilot sequence
15	message
16	detection of hidden nodes
17	frequency channel pattern
18	receiving window
K1-K6	frequency channel

Patentkrav

1. Fremgangsmåde til overførsel af data mellem en terminal og en datasamler (2) pr. radio, ved hvilken fremgangsmåde datasamleren (2) lejlighedsvis eller varigt befinder sig på modtagelse, og ved hvilken
terminalen fra en hvilefase opretter en kommunikation med datasamleren (2) for fuldstændigt eller delvist at sende dataene til datasamleren (2) og/eller modtage dem fra datasamleren (2), eller
datasamleren (2) opretter en kommunikation med terminalen for fuldstændigt eller delvist at sende dataene til terminalen og/eller modtage dem fra terminalen,
terminalen efter opbygningen af kommunikationen sender en meddelelse (15) til datasamleren (2), og datasamleren (2) efter modtagelsen af meddelelsen (15) på grundlag af meddelelsens (15) indhold under kommunikationen fortsætter, afbryder og/eller afslutter overførslen af dataene, og
overførslen af dataene sker i form af datapakker (11), som hver især omfatter flere datablokke (12) og/eller deldatablokke (13), hvorved
overførslen af dataene sker på et multiplum af frekvenskanaler (K1-K6), idet der til overførslen af dataene anvendes en frekvensspringfremgangsmåde, ved hvilken datablokkene (12) og/eller deldatablokkene (13) overføres på flere frekvenskanaler (K1-K6),
meddelelsen (15) omfatter en start/stop-information for at meddele datasamleren (2), at den fortsætter, afbryder og/eller afslutter overførslen af dataene, og
terminalen er et forbrugsmåleapparat (1) eller en sensor.

2. Fremgangsmåde ifølge krav 1, kendetegnet ved, at
terminalen i tidsmæssige intervaller fra hvilefasen udsender et radioopkald og derefter i en forudfastsat periode med henblik på opbygningen af kommunikationen med datasamleren (2) går på modtagelse, og/eller datasamleren (2) udsender et radioopkald med henblik på opbygningen af kommunikationen med terminalen, hvorved terminalen i tidsmæssige intervaller fra hvilefasen går

på modtagelse for at modtage radioopkaldet.

3. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at datasamleren (2) i tilfælde af, at den har modtaget terminalens radioopkald, til terminalen sender dataene og/eller et bekræftelsessignal for overførslen af dataene.

4. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at datasamleren (2) i tilfælde af, at den har modtaget terminalens radioopkald, afbryder overførslen af dataene og/eller sender et bekræftelsessignal til terminalen for afbrydelsen af overførslen af dataene.

5. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at meddelelsen (15) sendes i tidsmæssige intervaller, der kan fastlægges.

6. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at meddelelsen (15) hver gang sendes før og/eller efter en eller flere datablokke (12), deldatablokke (13) og/eller pilotsekvenser (14).

7. Fremgangsmåde ifølge krav 1, kendetegnet ved, at der gennemføres en vurdering af frekvenskanalernes (K1-K6) overførselskvalitet.

8. Fremgangsmåde ifølge krav 7, kendetegnet ved, at vurderingen af overførselskvaliteten gennemføres sådan, at modtagekanalen kontrolleres for skjulte knuder, og dataoverførslen afbrydes midlertidigt eller afbrydes, hvis der hen over modtagekanalen bestemmes skjulte knuder.

9. Fremgangsmåde ifølge krav 1, 7 eller 8, kendetegnet ved, at meddelelsen (15) genereres på grundlag af overførselskvaliteten af den pågældende frekvenskanal (K1-K6).

10. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at meddelelsen (15) omfatter en ACK/NACK-information for

at meddele datasamleren (2) og/eller terminalen, hvilke datablokke (12) og/eller deldatablokke (13) der er blevet vellykket overført.

11. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at datasamleren (2) og/eller terminalen gentagne gange sender de ikke vellykket overførte data, indtil disse er vellykket overført.

12. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at der er indrettet en synkroniseringssekvens til tids- og/eller frekvenssynkronisering af terminalen.

13. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at der til datablokkene (12) og/eller deldatablokkene (13) eller til et antal, der kan fastlægges, af datablokke (12) og/eller deldatablokke (13) er tilordnet en pilotsekvens (14).

14. Fremgangsmåde ifølge krav 13, kendetegnet ved, at pilotsekvensen eller pilotsekvenserne (14) er en del af synkroniseringssekvensen.

15. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at terminalen sender meddelelsen (15) på en første frekvenskanal og derefter er modtageklar på en anden frekvenskanal for på den anden frekvenskanal at modtage en mulig overførsel af dataene ved hjælp af datasamleren (2).

16. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at der ved overførslen af dataene er tale om en bidirektional dataoverførsel.

17. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at det ved overførslen af dataene drejer sig om en smalbåndsoverførsel.

18. Fremgangsmåde ifølge krav 17, kendetegnet ved, at den respektive modtagers modtagebåndbredde er mindre end 25 kHz,

fortrinsvis mindre end 20 kHz, fortrinsvis mindre end 5 kHz, fortrinsvis mindre end 3 kHz, særligt fortrinsvis mindre end 2 kHz.

19. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at det ved forbrugsmåleapparatet drejer sig om en vand-, varmemængde-, gas- eller strømmåler.

20. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at der er indrettet flere terminaler og/eller datasamlere (2).

21. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at dataraten i uplink i sammenligning med dataraten i downlink er større med i det mindste faktor 3, fortrinsvis med faktor 4, særligt fortrinsvis med faktor 5.

22. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at dataraten inden for en datablok (12) og/eller deldatablok (13) varieres.

23. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at der er indrettet i det mindste en sendepause især mellem sendingerne datablokke (12) og/eller deldatablokke (13), hvorved varigheden af sendepausen er dimensioneret sådan, at denne har i det mindste den samme længde som den respektive datablok (12) og/eller deldatablok (13).

24. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at datasamleren (2) efter modtagelsen af meddelelsen (15) bremser eller fremskynder overførslen af dataene, idet varigheden af sendepauserne forøges eller formindskes, og/eller dataraten nedsættes eller forhøjes.

25. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at der efter afbrydelsen og/eller den midlertidige afbrydelse af dataoverførslen fastlægges et tidsinterval indtil den fornyede overførsel og/eller fortsættelse af overførslen.

26. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at terminalen sender meddelelsen (15) for at meddele, at kommunikationen mellem datasamler (2) og terminal er dårlig, beskadiget eller suboptimal.

27. Fremgangsmåde ifølge et af de foregående krav, kendetegnet ved, at terminalen sender meddelelsen (15) for at meddele statussen for en energiforsyning (3a) til terminalen.

28. Fremgangsmåde ifølge krav 7, kendetegnet ved, at vurderingen af overførselskvaliteten sker på grundlag af signaleffekten og/eller den gennemsnitlige signaleffekt og/eller signaleffektens spredning på den respektive frekvenskanal (K1-K6).

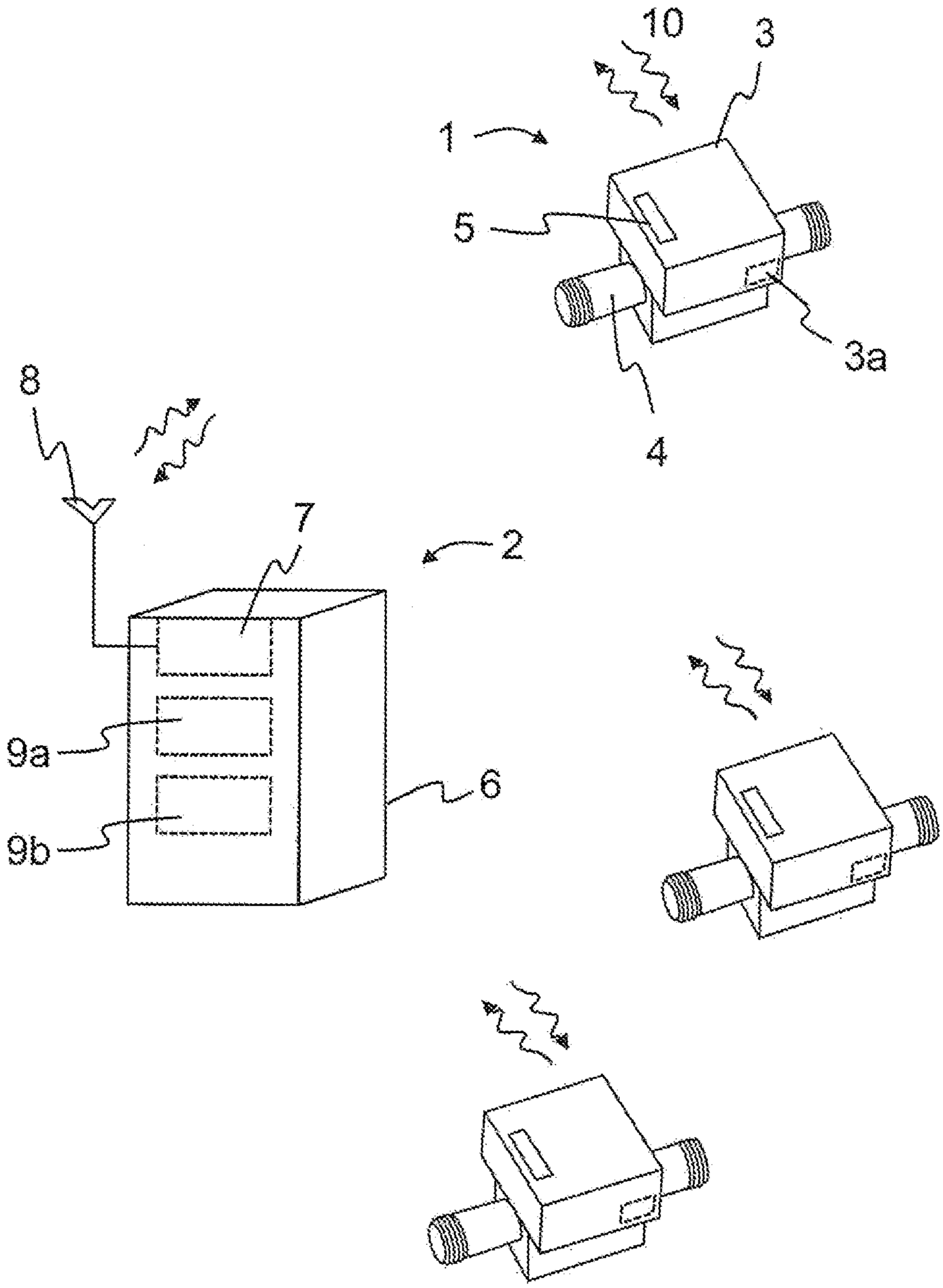

Fig. 1

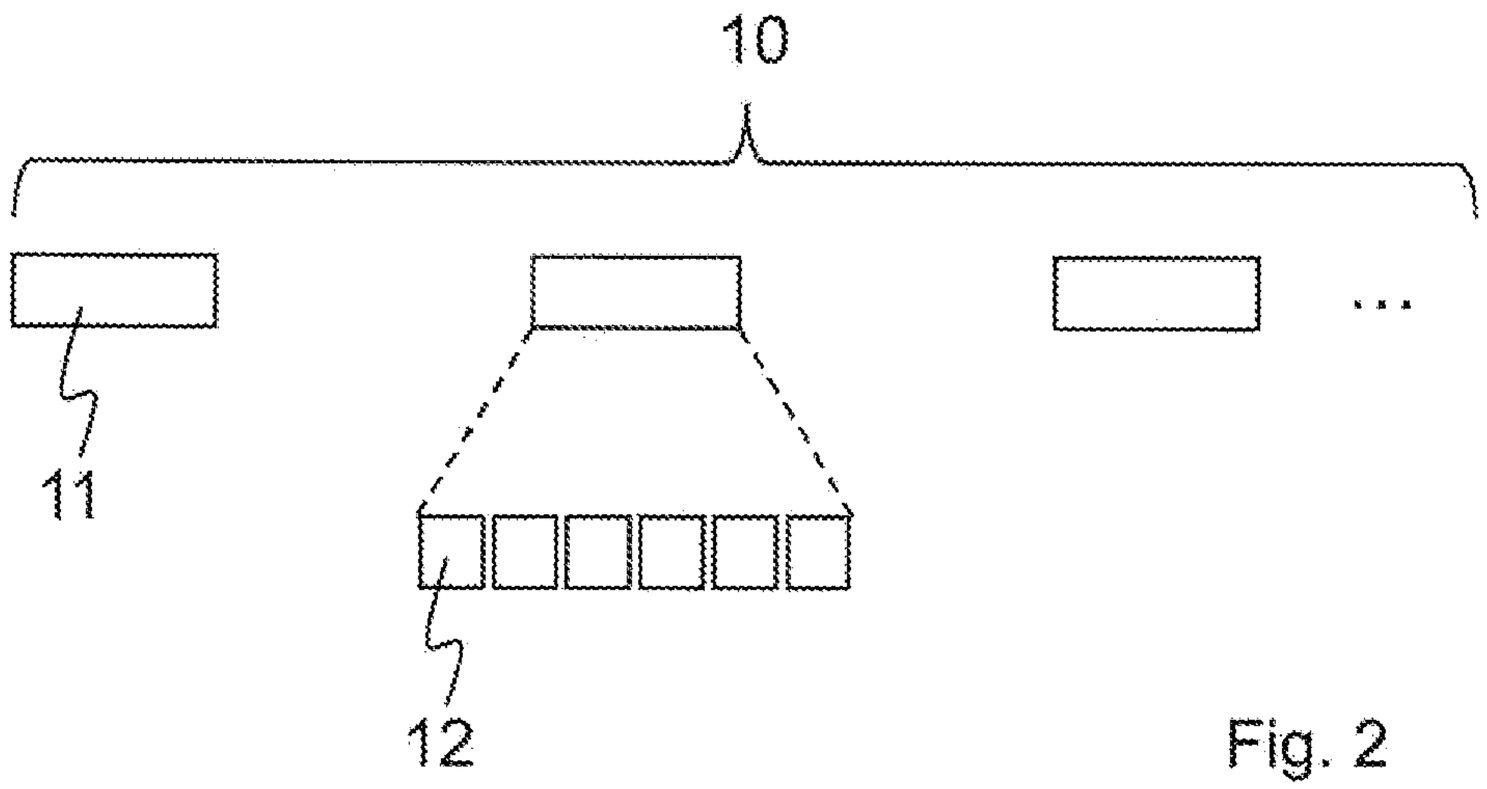

Fig. 2

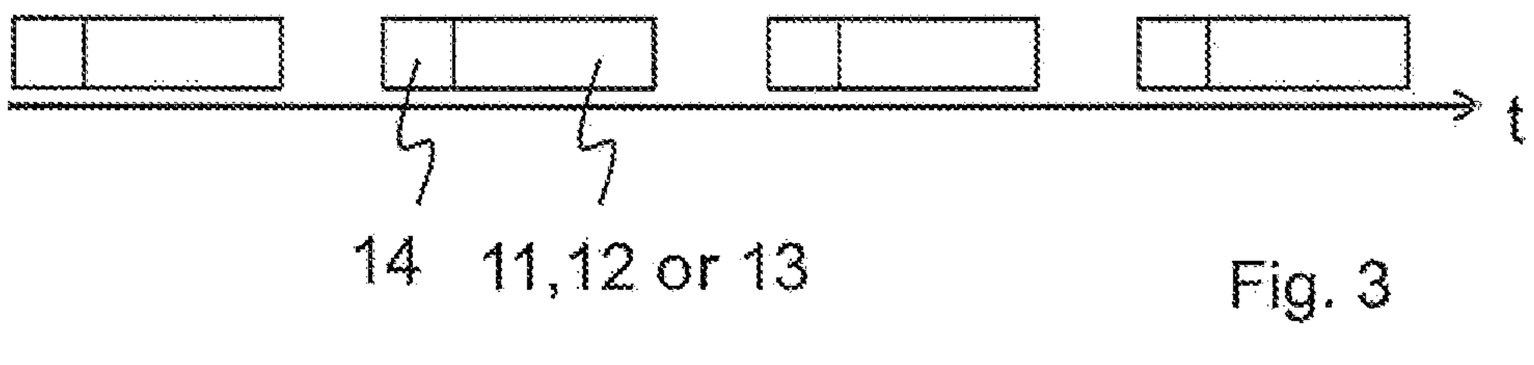

Fig. 3

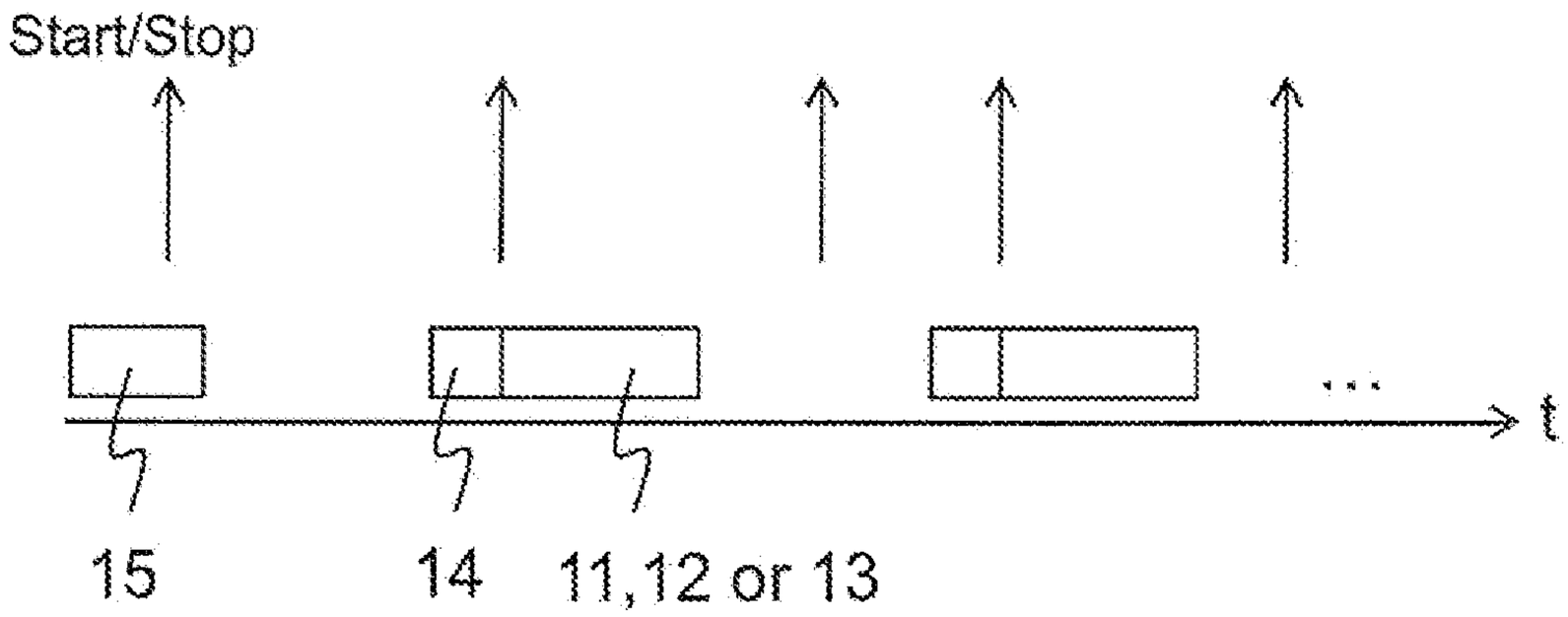

Fig. 4

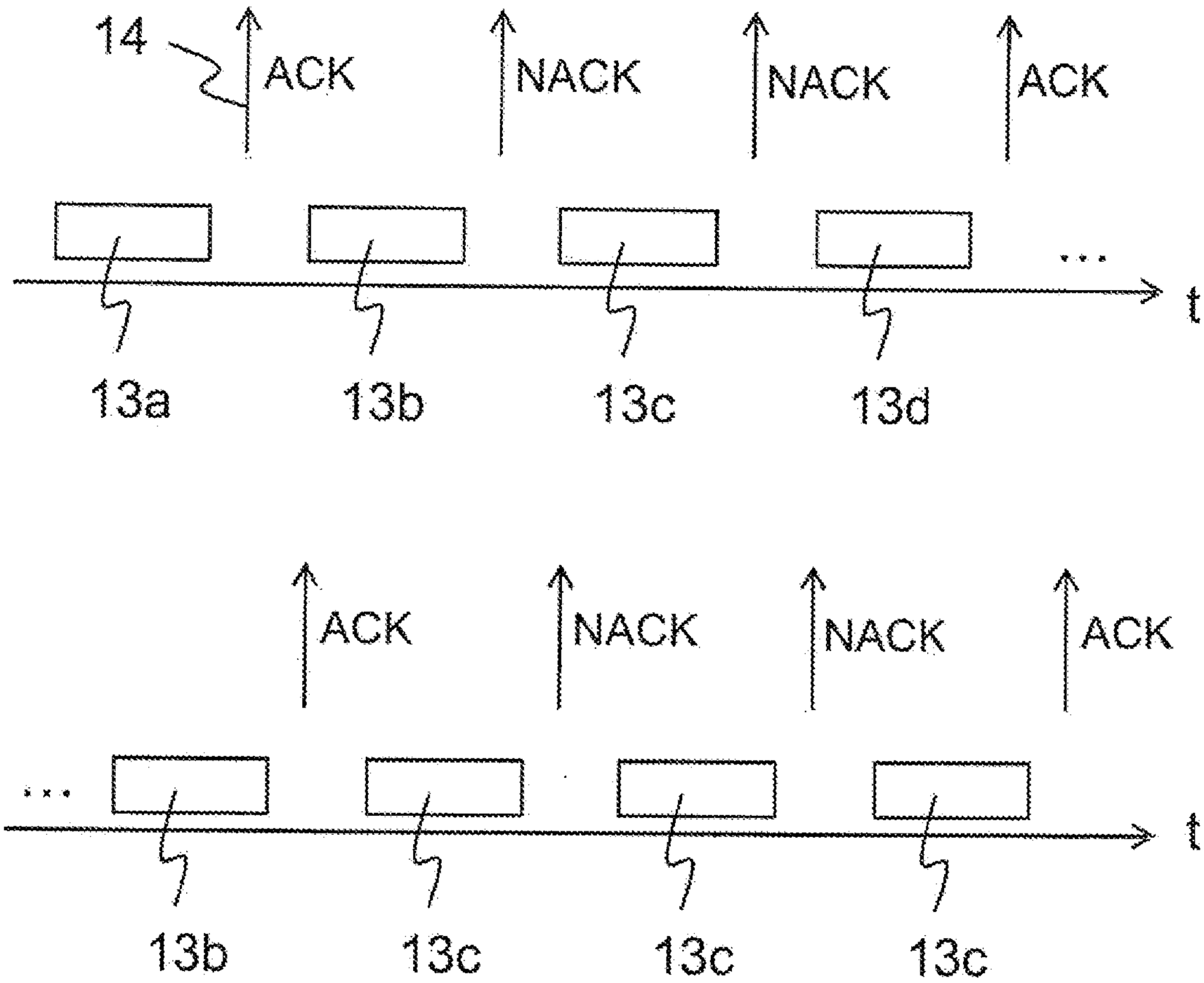
14
ACK
NACK
NACK
ACK
...
t
13a
13b
13c
13d
ACK
NACK
NACK
ACK
...
t
13b
13c
13c
13c

Fig. 5

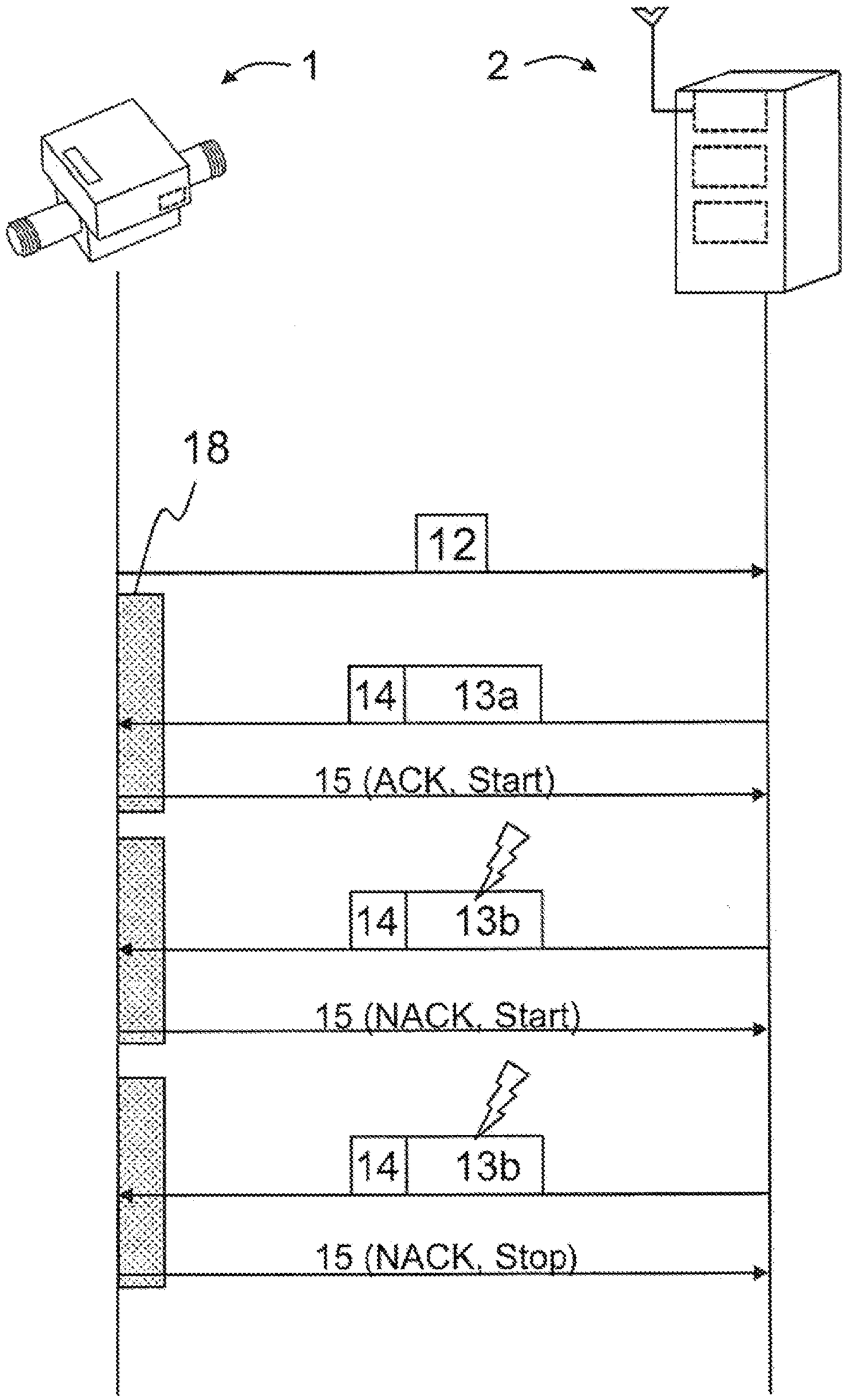
1
2
18
12
14
13a
15 (ACK, Start)
14
13b
15 (NACK, Start)
14
13b
15 (NACK, Stop)

Fig. 6

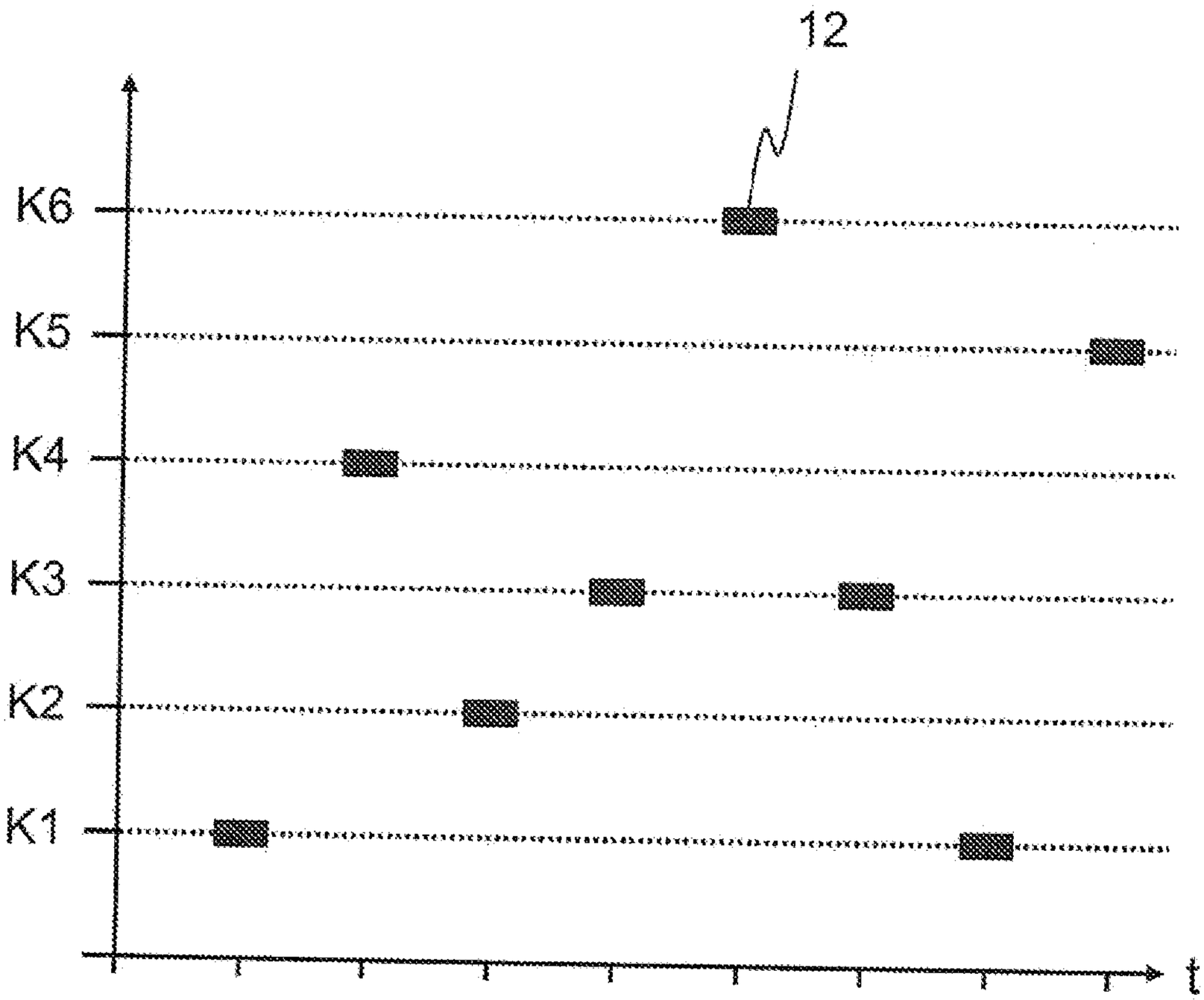

Fig. 7