A METHOD AND AN APPARATUS FOR REMOTE CONTROL OF A VEHICLE OR MOBILE ENGINE

In a method of remote control of a vehicle (1) for executing different motion phases and/or operation phases each phase has an associated control mode, in which control signals are transmitted from associated signal transmission means separate from the vehicle to signal receiving means (6, 13; 7, 16; 19, 20) on the vehicle, said receiving means being operatively connectable to manoeuvre means (12) of the vehicle by interconnected switching means (14; 17; 21) of each phase. For switching from a first control mode into a second control mode a command signal is supplied over first receiving means (6, 13), associated to the first control mode, and said switching means (14, 17) to second receiving means (7, 16) associated to the second control mode and lacking operative connection to said manoeuvre means (12) during the first phase. The command signal actuates said switching means to disconnect said first signal receiving means from said manoeuvre means and connect said second signal receiving means (7, 16) to said manoeuvre means (12) for executing the second phase. Check means (15; 18; 22) is provided between each receiving means and associated switching means to inhibit switching when incorrect control signals are received.
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A method and an apparatus for remote control of a vehicle or mobile engine

Technical field

The present invention relates to a method and an apparatus for remote control of a vehicle or a mobile engine in executing a sequence of motion phases and/or operation phases, such as driving up to a place, loading or unloading goods at this place and driving back from said place, during which sequence different control modes will take place such that the vehicle/engine is controlled according to a first control mode when a first phase is executed and at a transition from this phase to a second phase switching takes place to a second control mode, said remote control utilizing a system comprising signal transmitting means which are separate from the vehicle/engine, and signal receiving means on the vehicle/engine and which are operatively connectable to manoeuvre means of the vehicle/engine.

Background art

According to the prior art the remote control of said motion and operation phases or moments can take place according to several feasible control modes. If during the motion phase the route up to a working place is the same during a large number of sequences, it is suitable to use a control mode of guide cable control type which means that the vehicle/engine during driving follows an overhead cable or a cable buried in the ground, control signals being supplied to said cable. These signals generate an electromagnetic field around the cable, said field being detected by a set of antenna coils on the vehicle/engine. On the other hand, if the route is frequently changed, perhaps after each sequence, it is more convenient to use a control mode in which the control signals are transmitted by radio. Then, it is presupposed that an operator which continuously supervises the vehicle/engine attends to the remote control from a control console by means of which practically the same manoeuvres can be made as by that manoeuvre equipment which normally is found on the vehicle/engine.
In the operation phase following after the motion phase it is convenient to use the last mentioned control mode or even a manual control mode, since probably the operation phase often is changed.

Switching from one control mode to another and vice versa could be done automatically, e.g. when the transmission of control signals over one control mode is interrupted or ceases. Alternatively, the switching could be done according to a predetermined preference of the control modes. Said pre-requisites for the switching between the control modes could, however, cause non-desirable transitions, e.g. when the transmission of the control signals ceases as a result of a defect in the transmission.

Disclosure of the invention

The object of the present invention is to propose an automatically controlled switching or transition from one control mode to another, said switching eliminating non-desirable transitions caused by accident, out of spite or defects.

This object is achieved by performing the method mentioned by way of introduction as follows.

When transition is to take place from a first phase involving a first control mode in which first signal receiving means is operatively connected to manoeuvre means of the vehicle/engine to a second phase involving a second control mode, a command signals is supplied from signal transmitting means associated to said first control mode and over said first signal receiving means to second signal receiving means lacking connection to said manoeuvre means during said first phase. Said command signal includes instructions for switching into the second control mode and interrupts operative connection between said first signal means and said manoeuvre means as well as establishes, when said latter connection ceases, an operative connection between said second signal receiving means and said manoeuvre means for executing the second phase in the sequence of phases.
The apparatus for performing the method according to the invention includes a pair of signal transmitting means and signal receivers associated to each control mode, said transmitting means being separated from the vehicle/engine, and said receiver being located on the vehicle/engine and being provided for operative connection to the manoeuvre means of the vehicle/engine. A switching unit is provided between the signal receivers and said manoeuvre means for receiving from the receiver associated to the first control mode a command signal instructing switching into the second control mode for establishing an operative connection in the second commanded control mode. Said switching unit comprises members responsive to the command signal for inhibiting connections between said manoeuvre means and the signal receivers associated to not commanded control modes, as well as members responsive to the command signal for establishing an operative connection between said manoeuvre means and that signal receiver associated to the commanded control mode.

Brief description of the drawings

The invention is described in further details below with reference to the accompanying drawings.

Fig. 1 partly in a block diagram illustrates one embodiment where switching between a guide cable control mode and a radio control mode for a vehicle is provided for.

Fig. 2 is a block diagram showing how in various control modes different signal receiving means on the vehicle have operative connection to the manoeuvre means of the vehicle.

Fig. 3 illustrates by means of logic symbols one example of the structure and the mutual interconnection of switching means for facilitating over three alternative control modes operative connection between signal receiving means and manoeuvre means of the vehicle.

Mode for carrying out the invention and industrial applicability

Fig. 1 shows a remotely controlled vehicle 1 for carrying a load, by which vehicle sequences of motion phases and operation phases...
are executed. In the operation phase which can include e.g. loading or unloading at a working place 2, the vehicle is controlled by radio by an operator who is at a distance from the vehicle. The operator uses a manual control equipment 3 which includes the controls and manoeuvre means which are required for manoeuvring the vehicle. By said controls and manoeuvre means control signals are generated which over a radio transmitter 4 having an antenna 5 are transmitted to the radio antenna 6 of the vehicle. In a radio receiver connected to said antenna the received radio signals are converted to control signals which unambiguously depend on the signals originally generated in the control equipment 3 and which are allowed to act on the manoeuvre means of the vehicle as is explained in more details with reference to Fig. 2.

It is presupposed that when there are several vehicles at working place 2 each vehicle has its own operator which is responsible for the control of "his" vehicle. Then the radio control takes place over different channels in such a way that an operator neither inadvertently nor out of spite can interfere with a vehicle which is controlled by another operator. However, if convenient an operator can hand over the responsibility of control of "his" vehicle to another operator who due to his location has a better supervision. Then said handing over can be made by switching control modes according to the present invention. Such switching can also be made when a vehicle leaves a working place and is manoeuvred to another adjacent working place, where the responsibility of control is handed over to another operator. The process of handing over is subsequently described in detail.

During the motion phase when vehicle 1 transports material to or from working place 2 the vehicle is automatically controlled, signals for the control of the vehicle being transmitted to an inductive antenna 7 on the vehicle via a guide cable. In the figure the guide cable is supposed to be buried in the ground. However, said cable can also be an overhead cable. The guide cable defines the route to working place 2 and preferably is divided in so called blocks as is indicated by reference numerals 8a, 8b in Fig. 1 and is further elucidated in US patent specification No. 3.848.836. The automatic control is accomplished by a control equipment 9a,
9b associated to each guide cable block, said equipment being
connected to the respective guide cable block 8a, 8b by means
of a transmitter 10a, 10b. Obviously, several vehicles can be
driven along guide cable 8 and execute similar or different opera-
tion phases at working place 2. The control equipment controls the
passage along the guide cable such that the block closest ahead of
a block occupied by a vehicle shall be unoccupied, i.e. free
from vehicles, in order that said first mentioned vehicle shall be
allowed to continue its passage.

From the above it is obvious that switching according to the in-
vention between two control modes does not necessarily mean a
change of the signal transmitting medium but said switching can
also mean a change of radio channels or a transition from one guide
cable loop to another.

When the method involves multiple radio channels and/or multiple
guide cable loops each control mode realized by a radio channel
or a guide cable loop has a respective characteristic, such as a
channel number. In switching to any such control mode the command
signal used and described below will include said channel charac-
teristic.

In order to automatically switch from guide cable control to radio
control and vice versa there is at the end of block 8b a special
start block 11 which over a transmitter 10c is supplied with signals
from control equipment 9b. Vehicle 1 which via blocks 8a and 8b
enters block 11 here receives a command to stop; the vehicle
still communicates with control equipment 9b and receives its
commands therefrom. Via loop 11 and the inductive antenna 7 of
the vehicle control equipment 9b delivers a special command signal
for switching to radio control. As a consequence a switching described
with reference to Fig. 2 takes place, said switching making the
vehicle non-responsive to guide cable control signals but responsi-
ve to control signals transmitted over a predetermined radio
channel. Conversely, at the switching from radio control to guide
cable control vehicle 1 is, by means of the manual control equipment 3
and radio transmitter 4, manoeuvred in over block 11. Then, in a similar manner as mentioned above a command signal is transmitted for switching to guide cable control, whereupon the vehicle can be manoeuvred by the inductive transmission of control signals.

Fig. 2 shows manoeuvre means 12 of a vehicle, said means controlling both the speed an the direction of motion of the vehicle as well as its operative tools or equipment. Said manoeuvre means 12 is actuable in a radio control mode, a control mode for inductive transmission of the control signals to the vehicle and in an additional control mode, shown by dashed lines in the figure, which mode can be one of said control modes or a manual control mode, i.e. the operator controls the vehicle over a control console on the vehicle.

In the radio control mode the control signals are transmitted from manual control equipment 3 via transmitter 4 and its antenna 5 to a radio receiver 13 over its antenna 6. Between receiver 13 and manoeuvre means 12 there is switching means 14 by means of which the flow of signals from receiver 13 to said manoeuvre means 12 is controlled. Check means 15 connected between the receiver and said switching means check that the control signals are correctly transmitted and received. If this is not so said check means 15 inhibits switching means 14, thereby stopping the control signals from reaching manoeuvre means 12. Said checking of the control signals can be realized as parity and amplitude check and as identity check of the control mode, the transmitter and the receiver. The identity check means checking that for a certain control mode the control signals emanate from the correct transmitter and reach the intended receiver.

For the inductive control mode there is a receiver channel for inductive reception of control signals. The receiver channel comprises a receiver 16 connected to antenna 7, switching means 17 similar to switching means 14 and connected between receiver 16 and manoeuvre means 12, and check means 18 similar to check means 15. For the control mode illustrated in the figure in dashed lines there is a corresponding receiver channel including an antenna 19, a receiver 20,
switching means 21 and check means 22. Switching means 21 and check means 22 are identical to the above mentioned switching means 14, 17 and check means 15, 18, respectively.

In switching from one control mode to another switching means 14, 17 and 21 has an important role. Said switching means are interlocked to switch from one control mode to another control mode and transmit control signals over the latter mode only when predetermined conditions are met. These conditions are those mentioned in respect of check means 15, on one hand, and such conditions laid down to prevent undesirable or inadvertent switchings from one control mode to another, on the other hand. Said latter conditions will be discussed below in connection with description of Fig. 3.

Fig. 3 shows an example of the structure of a switching unit including switching means 14, 17 and 21 mentioned in connection with Fig. 2. Said switching means are identical, all have ten inputs i1-i10, five outputs u1-u5 and include six AND-gates A1-A6, two OR-gates O1, O2, and a monostable multivibrator FF serving as a memory member.

Input i1 is connected to one input of AND-gates A1 and A6, respectively, the other inputs of which are connected to the output of OR-gate O1 and "0"-output of multivibrator FF. Input i2 is connected to the output of AND-gate A1, the set-input of multivibrator FF and output u3. Inputs i3-i6 are connected to one input of AND-gates A2-A5, respectively, the other inputs of which all are connected to the output of AND-gate A6. Inputs i7 and i8 are connected to the inputs of OR-gate O1 and similarly inputs i9 and i10 are connected to the inputs of OR-gate O2. The outputs of AND-gates A2 and A3 are connected to the outputs u1 and u2, respectively and the outputs of AND-gates A4 and A5 are connected to outputs u4 and u5, respectively. Switching means 14, 17 and 21 are mutually interconnected as described below. In order to simplify identification of the inputs and outputs of the respective switching means reference numerals according to the following example will be used; 17i9 means input i9 of switching means 17; 14A3 means AND-gate A3 of switching means 14.
Outputs 14u1 and 14u2 are connected to inputs 21i8 and 17i7, respectively. Similarly 17u1 and 17u2 are connected to 14i8 and 21i7, respectively, and 21u1 and 21u2 are connected to 17i8 and 14i7, respectively. Moreover, there is a connection between 14u3, 17i9 and 21i9, between 17u3 and 21i10, and between 21u3, 14i10 and 17i10.

Inputs i1 for receiving input signals are connected to the respective check means, and presupposing that the control signals are correctly transmitted and received as described above a binary "1"-signal is supplied to this input when the respective control mode is actuated. Inputs i2 are manoeuvre signal inputs for manual selection of signal transmission mode. Inputs i3 and i4 also are manoeuvre signal inputs but are intended for automatic selection of another signal transmission mode and then are connected to the respective receiver. This is also the case for inputs i5 and i6 which are control signal inputs, i.e. over these inputs control signals are supplied for manoeuvring the vehicle. Said control signals are to be transmitted to manoeuvre means 12 of the vehicle via outputs u4 and u5, providing the above mentioned conditions are met.

By inputs i7 and i8 of e.g. switching means 14 it is possible to obtain over switching means 21 and 17, respectively, a change into signal transmission via that transmission mode to which switching means 14 belongs, i.e. radio. Of course, corresponding conditions hold for the other switching means 17 and 21. For instance, the switching off of the radio transmission mode for obtaining a change into any one of the other transmission modes takes place over inputs i9 or i10. The switching off of the other transmission modes which is the case when transmission has been established over a transmission mode, takes place over output u3.

Below follows by way of example a description of a manual connection into the radio control mode and an automatic change into the inductive control mode. By means of a binary "1"-signal supplied to input i2 multivibrator 14FF is triggered resulting in that the same signal appears on the output of multivibrator 14FF. In this way one condition of gate 14A6 is met; the other condition is met if
i1 receives a binary "1"-signal from check means 15, i.e. if the transmission between radio transmitter 4 and radio receiver 13 is found to be correct. Said signal on input 14i2 reaches over output 14u3 and inputs 17i9 and 21i9 to OR-gates 1702 and 2102 of switching means 17 and 21, respectively, and here causes reset of multivibrators 17FF and 21FF, respectively, i.e. the multivibrators are set to the state shown in Fig. 3 meaning stopping any control signals through switching means 17 and 21. If as mentioned above the conditions of gate 14A6 are met this means that gates 14A2, 14A3, 14A4 and 14A5 are enabled. Thus, control signals supplied by radio receiver 13 to inputs 14i5 and 14i6 can pass gates 14A4 and 14A5 and over outputs 14u4 and 14u5 reach manoeuvre means 12 in order to manoeuvre the vehicle in accordance to the control signals transmitted by radio.

In switching into an inductive control mode the following events take place: A switching signal in the form of a binary "1"-signal is transmitted by radio and is supplied to input 14i4 and from there to gate 14A3, which is already enabled, as mentioned above. The output signal of gate 14 A3 reaches through output 14u2, input 17i7 and OR-gate 1701 to AND-gate 17A1. At the same moment as it is recognized, by a signal over input 17i1, that the inductive signal transmission operates the conditions of gate 17A1 are met, resulting in that multivibrator 17FF is set to a binary "1"-state. In a corresponding way as described above regarding switching means 14 multivibrators 14FF will be reset to a binary "0"-state and consequently the signal transmission over inputs 14i5 and 14i6 and gates 14A4 and 14A5 to inputs 14u4 and 14u5 is interrupted.

It should be mentioned that if the number of alternative control modes are four instead of three as shown in Fig. 3 each switching means will have to be amplified to the following extent: An additional AND-gate is required with pertaining inputs and outputs of the switching means and having an operation analogous to that of AND-gates A2, A3. Moreover, OR-gates O1 and O2 each must have an additional input with corresponding inputs to the switching means. The corresponding amplification is required if the number of control modes is increased with still another mode.
Claims

1. A method of remote control of a vehicle (1) or a mobile engine for executing a sequence of motion phases and/or operation phases, such as driving up to a place (2), loading or unloading of goods at this place and driving away from said place, during which sequence different control modes will exist, such that the vehicle/engine is controlled according to a first control mode when a first phase is executed and at the transition from this phase to a second phase there is a change into a second control mode, said remote control utilizing a system comprising signal transmitting means (3, 4, 5; 8, 9, 10, 11) being separated from the vehicle/engine (1) and signal receiving means (6, 13; 7, 16; 19, 20) on the vehicle/engine (1), said receiving means being operatively connectable to manoeuvre means (12) of the vehicle/engine (12), characterized in that at the end of said first phase during which first signal receiving means (e.g. 6, 13) is operatively connected to said manoeuvre means (12), a command signal for switching into said second control mode is supplied from signal transmitting means (e.g. 4, 5) associated to said first control mode, over said first signal receiving means (6, 13) to second signal receiving means (e.g. 7, 16) lacking operative connection to said manoeuvre means (12) during said first phase, said command signal interrupting the operative connection between said first signal receiving means (6, 13) and said manoeuvre means (12) and establishing, when said latter connection ceases, an operative connection between said second signal receiving means (17, 18) and said manoeuvre means (12) for executing said second phase in the sequence of phases.

2. A method as claimed in claim 1, characterized in that at least one pair of the pairs of said signal transmitting (3, 4, 5; 8, 9, 10, 11) means and signal receiving means (6, 13; 7, 16; 19, 20) associated to said control modes operates over another transmitting medium than the remaining pairs.
3. A method as claimed in claim 1 or 2, characterized in that at least two pairs of the pairs of said signal transmitting and signal receiving means associated to the control modes operate over mutually similar medium, that said at least two pairs have a channel characteristic corresponding to the respective control mode and that the command signal for switching to any one of said just mentioned control modes has a characteristic designating the desired channel.

4. A method as claimed in claim 1, characterized in that said second signal receiving means is operatively connected to said manoeuvre means first when it is established according to a predetermined rule that control signals are correctly transmitted from signal transmitting means associated to said second control mode to said second signal receiving means.

5. An apparatus for remote control of a vehicle (1) or a mobile engine by means of manoeuvre means (12) for executing a sequence of motion phases and/or operation phases, such as driving up to a place (2), loading or unloading of goods at this place and driving away from the place, during which sequence different control modes are to exist, said vehicle/engine (1) being controlled according to a first control mode during a first phase and at a transition from this first phase to a second phase a change taking place into a second control mode, which apparatus comprises signal transmitting means (3, 4, 5; 8, 9, 10, 11) separated from the vehicle (1) and signal receivers (6, 13; 7, 16; 19, 20) located on the vehicle and provided to be operatively connected to the manoeuvre means of the vehicle/engine, characterized in that a switching unit (14; 17; 21) is provided between the signal receivers (6, 13; 7, 16; 19, 20) and said manoeuvre means (12) of the vehicle/engine (1) in order to establish by means of a command signal instructing switching into the second control mode and transmitted from a signal receiver associated to the first control mode, an operative connection in the second commanded control mode, that said switching unit has members (O2, FF, A6) responsive to the received command signal for inhibiting
connections between said manoeuvre means (12) and signal receivers associated to not commanded control modes, and members (01, A1, FF, A6, A4, A5) responsive to said command signal for establishing an operative connection between said manoeuvre means (12) and that signal receiver associated to the commanded control mode.

6. An apparatus as claimed in claim 5, characterized in that the switching unit comprises switching means (14; 17; 21) associated to each signal receiver which switching means are mutually connected, that each switching means (14; 17; 21) comprises said inhibit members (02, FF, A6) which are responsive to a command signal received in that control mode to which said switching means is associated, and said operative connection establishing members (01, A1, FF, A6, A4, A5) which are responsive to a command signal received in another control mode than the one to which said switching means is associated.

7. An apparatus as claimed in claim 6, characterized in that in each switching means the members (01, A1, FF) for establishing operative connection comprise a circuit (12) for actuating these members for manually establishing that control mode to which said switching means is associated, and that the circuit via the mutual connections of the switching means is connected to the inhibit members (02, FF, A6) of the other switching means for actuating said inhibit members.

8. An apparatus as claimed in any one of claims 5 to 7, characterized in that at least one pair of the pairs of signal transmitting means (3, 4, 5; 8, 9, 10, 11) and signal receivers (6, 13; 7, 16; 19, 20) associated to the control modes operates over another transmitting medium than the remaining pairs.

9. An apparatus as claimed in any one of claims 5, 6 and 8, characterized in that at least two pairs of the pairs of signal transmitting means (3, 4, 5; 8, 9, 10, 11) and the signal receivers (6, 13; 7, 16; 19, 20) operate over mutually similar transmitting media, and that said at least two pairs have a respective channel.
characteristic corresponding to the associated control mode; and that the command signal for the switching to any one of said just mentioned control modes has a characteristic designating the desired channel.

10. An apparatus as claimed in any one of claims 5 to 7, characterized in that check means (15; 10; 22) is associated to each signal receiver (6, 13; 7, 16; 19, 20), said check means operating according to a predetermined rule for checking that correct signals are received by the signal receiver, and that said check means is connected to said switching means of the signal receiver for inhibiting said switching means if incorrect signals are received by the signal receiver.
INTERNATIONAL SEARCH REPORT

International Application No. PCT/SE81/00191

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC:

B 62 D 1/28, G 05 D 1/03

II. FIELDS SEARCHED

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Documentation Searched other than Minimum Documentation to the extent that such documents are included in the fields searched:

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT

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“X” document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search: 1981-09-10

Date of Mailing of this International Search Report: 1981-09-14

International Searching Authority: Swedish Patent Office

Signature of Authorized Officer: Gunnar Hildesrot