(19) DANMARK

(10) **DK/EP 3158656 T3**

Patent- og Varemærkestyrelsen

(12) Oversættelse af europæisk patentskrift

(51) Int.Cl.: ***H 04 B 3/56 (2006.01)*** ***H 04 B 3/54 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2020-02-10**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2019-11-06**

(86) Europæisk ansøgning nr.: **15738724.2**

(86) Europæisk indleveringsdag: **2015-06-17**

(87) Den europæiske ansøgnings publiceringsdag: **2017-04-26**

(86) International ansøgning nr.: **FR2015051607**

(87) Internationalt publikationsnr.: **WO2015193615**

(30) Prioritet: **2014-06-18 FR 1455616**

(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 RS SE SI SK SM TR**

(73) Patenthaver: **Bernard Controls, 4, rue d'Arsonval, 95500 Gonesse, Frankrig**

(72) Opfinder: **AUBER MAGUERO, Gilles, 17 rue du Colonel Oudot, 75012 Paris, Frankrig**
FAURE, Guillaume, 39 rue Dulong, 75017 Paris, Frankrig
SCHWEBEL, Dominique, 28 rue de la Marne, 93360 Neuilly Plaisance, Frankrig

(74) Fuldmægtig i Danmark: **Plougmann Vingtoft A/S, Strandvejen 70, 2900 Hellerup, Danmark**

(54) Benævnelse: **SYSTEM TIL STYRING AF MINDST EN SERVOMOTOR FRA EN KONTROL-/STYRECENTRAL**

(56) Fremdragne publikationer:
WO-A1-2008/145160
WO-A2-2008/156741
GB-A- 1 122 801
JP-A- 2007 027 041
JP-A- 2010 220 155

Description

The invention relates to a system for controlling at least one servomotor from a command/control center, of the type comprising a grid for supplying the servomotor with electrical energy and means for transmitting electrical control signals to the servomotor, from a control center.

Several systems of this type are already known. Thus, it is known in a powerline communication (PLC) system to superimpose, on the 50 or 60 Hz alternating electrical current, a higher-frequency and lower-intensity signal. When such a PLC system includes several servomotors, the latter are mounted in series, such that the control signal intended for a servomotor must pass through the servomotor arranged upstream from the receiving servomotor. It is only the first servomotor that is coupled directly to the modem emitting the signal.

Given that the electrical grid is not shielded and the impedance is generally not adapted, the majority of the energy injected by the PLC modem or by one servomotor intended for a following servomotor is attenuated. As a result, the maximum distance between the modem and the first servomotor and between two adjacent servomotors in the series is unsatisfactory. Another major drawback of this system is that if one of the servomotors fails, the modem can no longer dialogue with the servomotors located downstream from the faulty servomotor.

Another known system, with a point-to-point connection where each servomotor is supplied directly from the electrical cabinets and is coupled directly via a cable to the command/control center, has the drawback that the cable must be a multi-wire cable, the number of wires of which can reach around fifteen.

Still another known system uses a fieldbus to replace the point-to-point connection, and therefore to replace the cable containing around fifteen wires with a cable with two wires. On such a fieldbus, the servomotors are placed in series. The system

has the major drawbacks that for the fieldbus, it is necessary to use a specific and therefore expensive shielded cable, in terms of both the purchase cost and the on-site installation work. Additionally, a failure in terms of one servomotor or line can cause the entire system to fail. In order to improve the reliability of the fieldbuses, redundancy is used by duplicating each cable, which nevertheless makes the system even more expensive.

Also known are wireless systems having the major drawback that the servomotors must be placed so as to create a field such that each servomotor can relay the signal to the following servomotor, which is very restrictive. Additionally, because they use radio links, they are not sufficiently immune to scrambling. WO2008/156741A2 discloses a control system for a plurality of servomotors according to the preamble of claim 1.

The invention aims to propose a system that addresses the drawbacks of the known systems.

To achieve this aim, a system according to the invention is characterized in that the control signal transmission means are formed by at least one communication wire integrated into the power cable.

According to another feature of the invention, the system is characterized in that the control signals are applied between a power supply wire and the communication wire, and in that the latter is electrically insulated from the phase wire at both of its ends.

According to still another feature of the invention, the system is characterized in that it comprises electrical insulation at both ends of the communication wire, suitable for separating the power signals.

According to still another feature of the invention, the system is characterized in that the signals are frequency-modulated and include three frequencies, a carrier frequency and

two frequencies respectively representing the digital values "0" and "1".

According to still another feature of the invention, the system is characterized in that it comprises a direct current supply device for the devices on the servomotor side, from the command/control center side.

According to still another feature of the invention, the system is characterized in that the power supply cable of the servomotor comprises three phase wires for the power, one ground wire and one communication wire.

According to still another feature of the invention, the system is characterized in that the power supply cable of the servomotor comprises a mono-phase device with two wires for power, a ground wire and a communication wire.

According to still another feature of the invention, the system is characterized in that it comprises, for the power supply of a servomotor, by the direct current, two wires for power, a ground wire and a communication wire.

According to still another feature of the invention, the system is characterized in that the control/command center communicates with a servomotor by means of an interface modem to which the communication wire and the reference phase are connected.

According to still another feature of the invention, the system is characterized in that it includes a single control/command center that communicates with a plurality of servomotors using a concentrator to which the interface modems of the servomotors are connected by means of a link of the fieldbus type.

The invention will be better understood, and other aims, features, details and advantages thereof will appear more clearly in the following explanatory description done in reference to the appended drawings, provided solely as an example illustrating one embodiment of the invention, and in which:

- figure 1 is a schematic view of a first embodiment of a control system of at least one servomotor according to the invention,
- figure 2 is a view similar to figure 1, showing a second version of the system according to the invention; and
- figure 3 is a schematic view of still another version of the system according to the invention.

Figures 1 and 2 show, as a nonexclusive example, two embodiment versions of a system for controlling electric servomotors according to the invention.

In the illustrated example, references 1 and 2 respectively designate a servomotor and the beginning of the power supply line of the servomotor, by means of a power cable 5 that includes three phase wires while forming a three-phase device.

One major particularity of the invention lies in the fact that this cable includes a separate wire, called communication wire 7, that is integrated into the power cable 5 while being electrically insulated from the power wires.

The communication wire 7 serves to allow a command/control center 9 to dialogue with the servomotor 1. To that end, the communication signals are applied between one of the supply phase wires 5, denoted 5a in the figures, and this communication wire 7. These signals have a much higher frequency than that of the alternating current and a much lower amplitude.

It should be noted that the system according to the invention works for other types of supply, namely mono-phase and direct current. The supply cable of the servomotor can therefore have:

- in three-phase, three phase wires for the power, a ground wire and a communication wire;
- in mono-phase, two wires for the power, one ground wire and one communication wire;

- in direct current, two power wires, one ground wire and one communication wire.

Given that the communication signals pass between a phase wire and the additional communication wire, the risk of disruptions of the grid is much lower than in known systems passing signals between two phases, which does not require respecting strict setpoints to avoid disrupting the grid. However, given that the signals are on one phase, they must be insulated at the beginning and end of the line. This insulation will be done through an electrical insulation that makes it possible to separate the signals from the power.

More specifically, as shown in figure 1, on the side of the command/control center 9, that is to say, on the user side, a modem 11 is connected, on the one hand, by a terminal 12 to the command/control center 9, and on the other hand, in 14 by two terminals between the communication wire 7 and the phase wire 5a on which the communication signals are superimposed. The direct current supply of the modem is provided by a device 15 that produces the direct current from two phases 5 of the power supply of the servomotor.

On the servomotor side 1, a modem 17 is associated with the latter by means of a smart interface 18. It is also connected in 19 between the communication wire 7 and the phase wire 5a and receives, in 21, from the smart interface 18 of the servomotor, communication signals that must be sent to the command and control interface 9. In 23, the interface 18 also supplies the modem 17 with direct current.

The electrical isolation relative to the phases is provided in 16 in the modems 11 and 17 respectively on the command/control center side and servomotor side.

Thus, on the modem 11 side, the supply 15 and the signals at the terminal block 12 are insulated from the phases 5. Likewise, on the modem 17 side, the power supply 23 and the communication signals in 21 are insulated from the phases.

Figure 1 also illustrates, in 24 in broken lines, the possibility of extending the communication wire to a command and control center assembly 9' provided with a modem 11' that is separated from the beginning of the power supply line 2, whereas generally, the modems are arranged close to the power initiation, if applicable on the power site itself.

Figure 2 shows a system according to the invention, which makes it possible to continue a communication between the servomotor and the command and control center 9, even in case of loss of the power supply. For such a case, the system comprises, on the command/control center 9 side, a separate direct current supply device 25 that supplies the direct current by means of a DC/DC converter 27 to the modem 11. The supply, after having been insulated, is connected between the phase wire 5a and the communication wire 7. The communication signal is superimposed on this supply. The direct current supply and the communication signal are recovered at the servomotor, by the modem 17, insulated and connected to the smart interface 18 in 21, and by means of a DC/DC converter 31. The converter 31 converts the direct voltage into DC power and supplies the interface 18 in 29, which next supplies the modem 17 in 23.

It should be stressed that, in a system according to the invention, the distance between the sending modem on the user side and the servomotor, that is to say, the maximum length of the communication wire, is at least 500 meters. In the case of a system according to figure 2, the maximum length can be even greater.

It should also be noted that it is possible to inject the signal relative to all three phases at the same time, so as not to have, on the actuator side, to determine the proper reference phase of the communication signal.

Figure 3 shows the system according to the invention in a version suitable for controlling a plurality of different servomotors 1 using a single control/command center 9, by means

of a data concentrator 33 that constitutes an interface between the command/control center and the modems 11, which each form the interface of a servomotor 1. The data, namely the controls and signals of the servomotors, are concentrated in the concentrator, that is to say, at a single point. The interface modems 11 are connected to one another and to the concentrator via a connection of the fieldbus 35 type. The concentrator 33 is also connected to the command/control center 9 by a connection of the fieldbus 37 type, which can be of a different type from that connecting the concentrator to the modems.

In this system, an address is assigned to each interface modem 11, which allows the concentrator 33 to determine the origin of a signal and to communicate an order to the receiving servomotor. The fieldbus 33 can be redundant so as to increase the security of the system.

The system according to figure 3 has the advantage of reducing the number of cables between the control/command center 9 and the interface modems 11 that may be located with the power line initiation 2 on a power site.

Regarding the operation of the system according to the invention, the signal superimposed on the supply voltage is of the FSK type, that is to say, a frequency-modulated signal. Three frequencies are necessary in order to encode a message, namely a carrier frequency, a frequency equivalent to the value "0" and another frequency that corresponds to "1". These last two frequencies are defined as a function of the carrier and the throughput, which can for example be chosen between 600 bits/sec and 4800 bits/sec. The available carriers can be chosen, for example, between 60 kHz and 132.5 kHz. The frequencies of '1' and "0" could, as a function of the aforementioned throughputs, for example be in the order of 60 kHz to 135 kHz. It is advantageous to provide electrical insulation between the wires of the phase connected to the sector and the communication wire with the other communication circuits. In this case, an

insulation failure between phase and communication wire cannot be transmitted over the command circuits.

The invention as disclosed and shown in the figures, as a non-limiting example, has many advantages.

Relative to a known grid, at the carrier current, the distance between the modem and the servomotor is at least 500 meters. Additionally, each servomotor currently has its own supply line. With the disclosed system, each servomotor stays with a single power cable including the communication wire, which has the advantage for the user of not having to change the supply architecture of the servomotors. Therefore, in case of failure, it does not affect the other servomotors. The signal being located between a phase and an insulated wire of the grid, due to this insulation, the invention with communication wire allows higher amplitudes of the signal while avoiding polluting the electrical grid, and is less sensitive to parasites, which makes it possible to satisfy stricter standards. Indeed, owing to the invention, the electrical grid is polluted less. As a result, the maximum tolerated levels can be lower and therefore more strict.

Relative to the known point-to-point connection systems, the cable that connects the servomotor to the command/control center is eliminated and replaced by a simple wire added in the power cable, resulting in economic gains in terms of raw materials and labor. It is necessary to connect only five wires in the case of a three-phase system, instead of approximately twenty. It should be noted that cables containing five conductors are commonly used in the industry and do not raise any supply problems.

Relative to a known system of the fieldbus type, the invention has the advantage that instead of using a specific and therefore expensive cable, it only needs, for the communication wire, a similar additional conductor in the power supply cable of the servomotor. Furthermore, the invention does not need

redundancy, since only one servomotor is connected to a communication wire connection. Each servomotor has its own power cable, and therefore its own communication wire connection.

Patentkrav

1. System til styring af mindst en servomotor fra en kontrol-/styrecentral af den type, der omfatter et net til forsyning af servomotoren med elektrisk energi og midler til transmission af elektriske styresignaler til servomotoren fra en kontrol-/styrecentral, **kendetegnet ved, at** forsyningsnettet udgøres af et kabel, der omfatter mindst en ledning til strømforsyning (5a), og midlerne til transmission af signaler udgøres af mindst en kommunikationsledning (7), der er integreret i strømkablet (5), **at** styresignalerne pålægges mellem strømforsyningsledningen (5a) og kommunikationsledningen (7), og **at** denne sidstnævnte er elektrisk isoleret fra strømforsyningsledningen ved sine to ender for at gøre det muligt at adskille styresignalerne fra strømforsyningen.

2. System ifølge krav 1, **kendetegnet ved, at** det omfatter en elektrisk isolering ved de to ender af kommunikationsledningen (7), der er egnet til at adskille signalerne fra strømforsyningen.

3. System ifølge et af kravene 1 til 2, **kendetegnet ved, at** signalerne er frekvensmodulerede og har tre frekvenser, en bærefrekvens og to frekvenser, der repræsenterer henholdsvis de digitale værdier "0" og "1".

4. System ifølge et af kravene 1 til 3, **kendetegnet ved, at** det omfatter en indretning til forsyning af indretningerne på servomotorsiden med jævnstrøm fra kontrol-/styrecentralsiden.

5. System ifølge et af kravene 1 til 4, **kendetegnet ved, at** kablet til strømforsyning til servomotoren omfatter tre faseledninger (5) til strømforsyningen, en jordledning og en kommunikationsledning.

6. System ifølge et af kravene 1 til 5, **kendetegnet ved, at** kablet til strømforsyning til servomotoren omfatter en enfaseindretning med to ledninger til strømforsyningen, en jordledning og en kommunikationsledning.

7. System ifølge et af kravene 1 til 6, **kendetegnet ved, at** det til strømforsyning af en servomotor med jævnstrøm omfatter to ledninger til strømforsyningen, en jordledning og en kommunikationsledning.

8. System ifølge et af kravene 1 til 7, **kendetegnet ved, at** styre-/kontrolcentralen (9) kommunikerer med en servomotor (1) ved hjælp af et grænsefladem odem (11), med hvilket kommunikationsledningen (7) og referencefasen (5a) er forbundet.

9. System ifølge et af kravene 1 til 7, **kendetegnet ved, at** det omfatter en enkelt styre-/kontrolcentral (9), som kommunikerer med et antal servomotorer (1) ved hjælp af en koncentrator (33), til hvilken servomotorernes grænsefladem odemer (11) er forbundet ved hjælp af en forbindelse (35), såsom af typen feltbus.

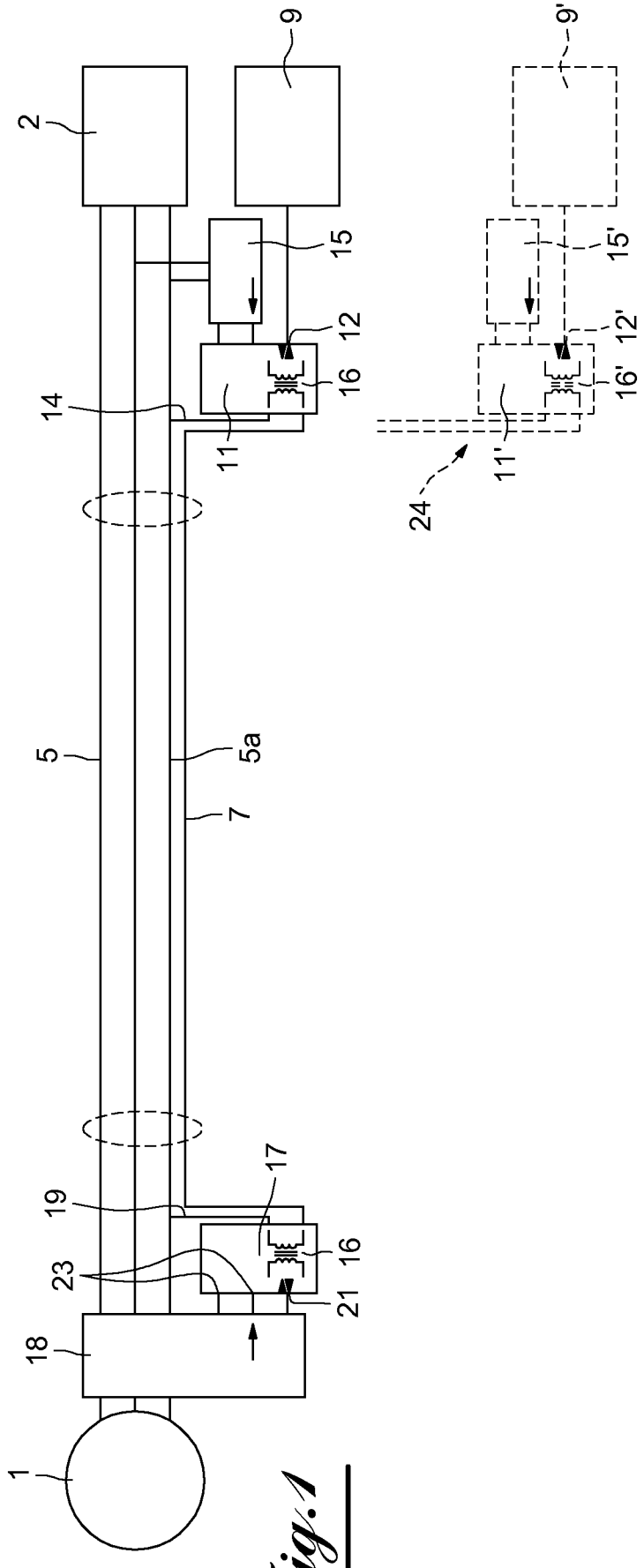
1
18
19
23
21
16
17
5
5a
7
14
11
12
16
15
2
9
9'
15'
12'
16'
11'
24

Fig.1

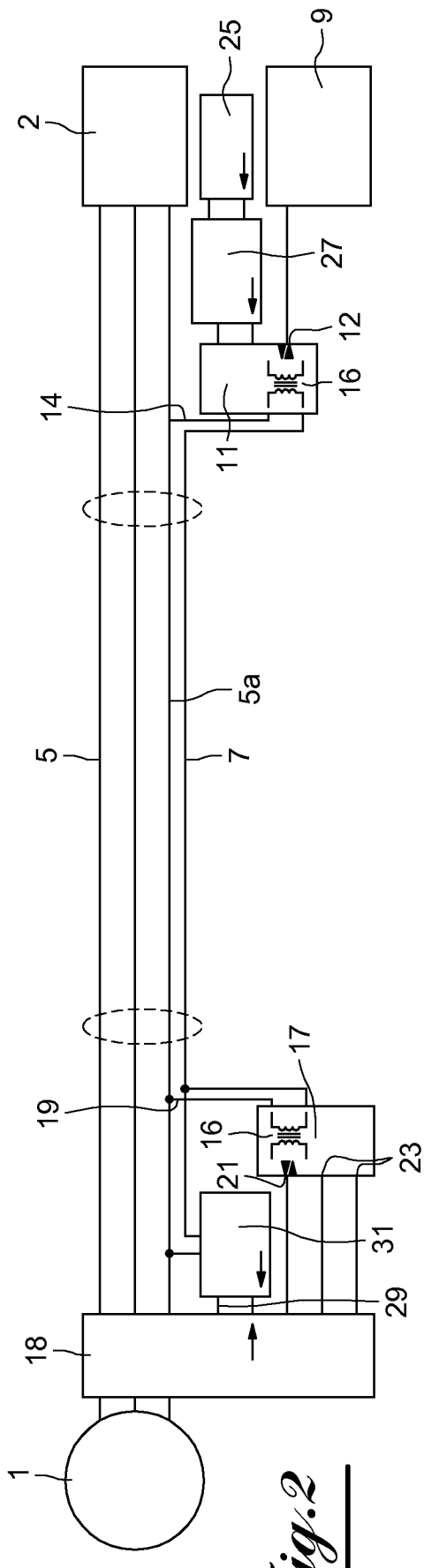
1
18
19
16
17
21
23
31
29
5
5a
7
14
11
12
16
27
25
2
9

Fig.2

Fig.3