March 7, 1939. A. YTTERBERG 2,149,486

METHOD AND ARRANGEMENT FOR SIGNALING OVER ALTERNATING CURRENT NETWORKS

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Fig.1

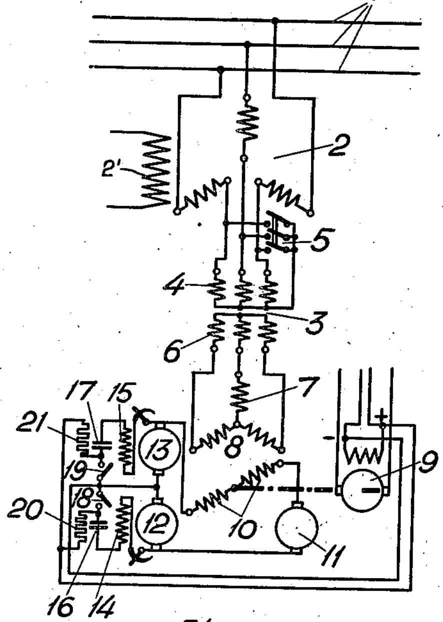

Fig.2

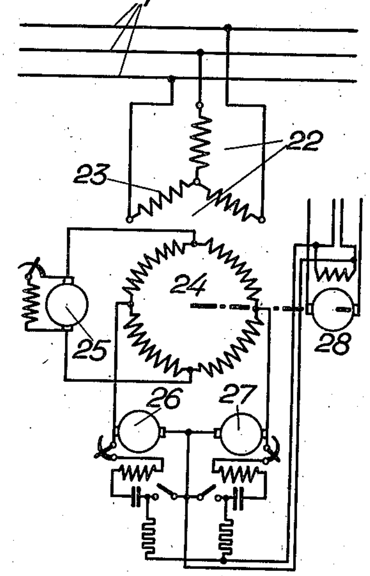

Fig.3

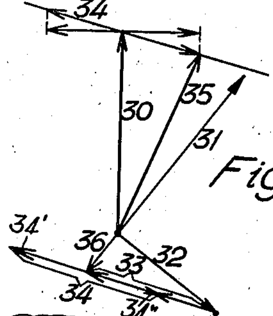

Fig.4

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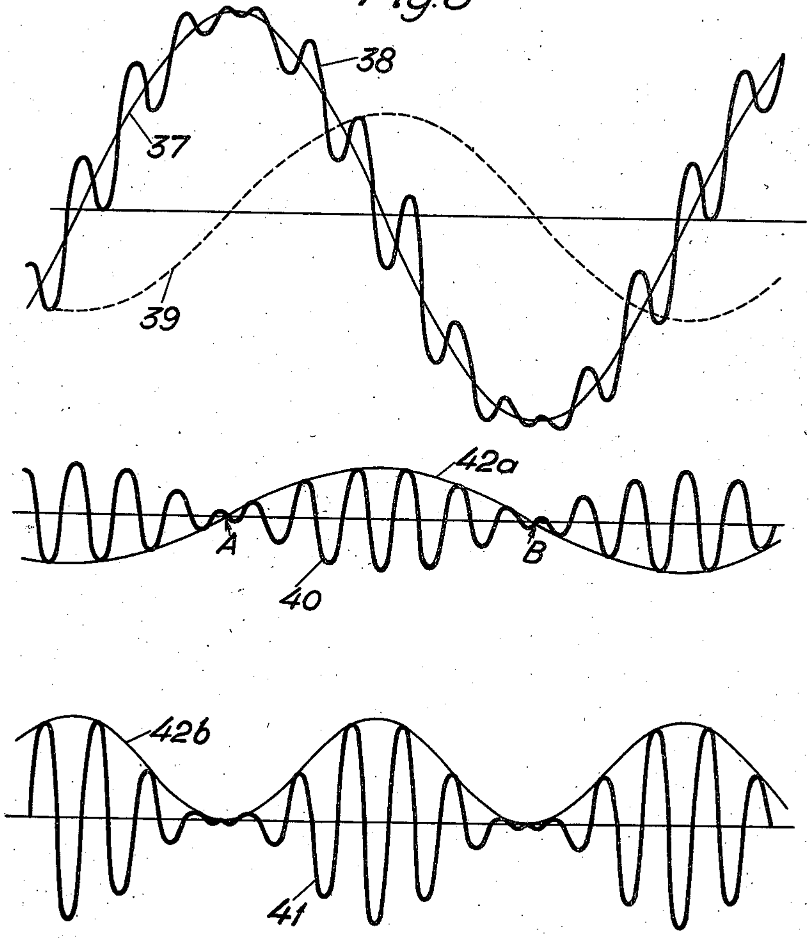
Fig. 5



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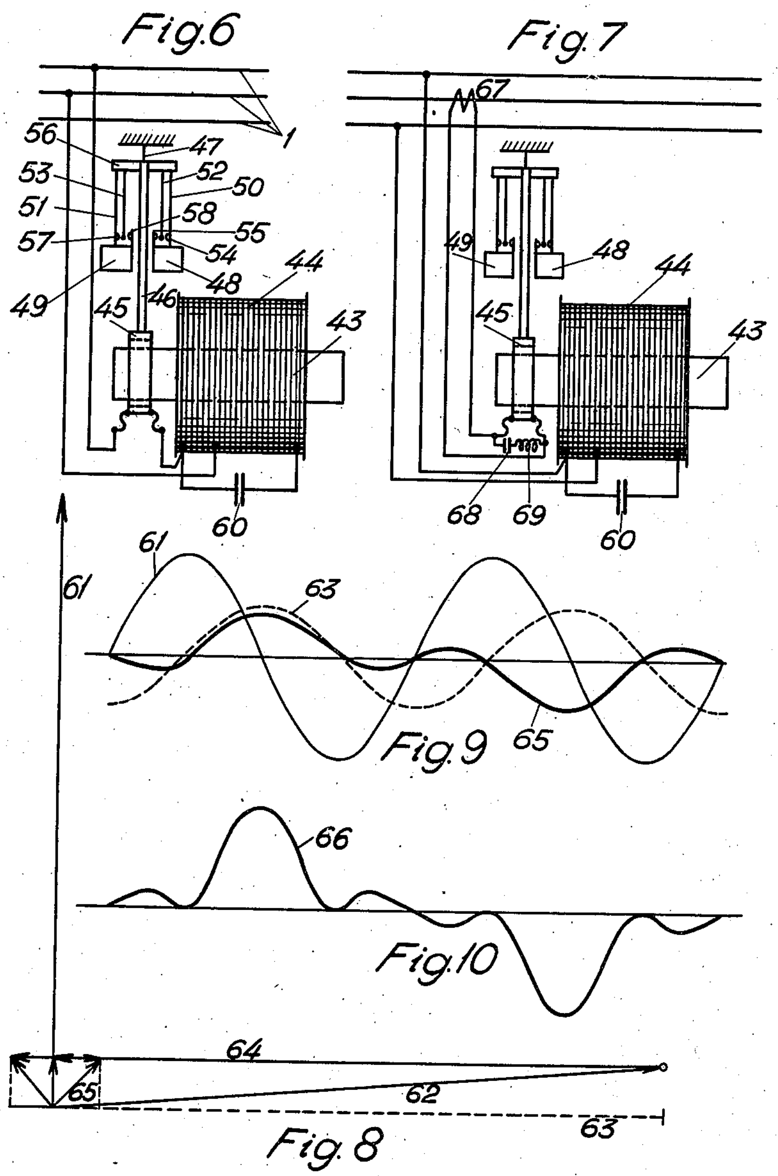

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METHOD AND ARRANGEMENT FOR SIGNALING OVER ALTERNATING CURRENT NETWORKS

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3 Claims. (Cl. 177—352)

The present invention relates to a method and devices for signaling, remote control or the like over power networks by means of a modulated alternating voltage superimposed on the constant voltage of the network and with the same frequency as the network voltage.

The invention is mainly characterized in that the signals sent out on the network are received by a coaction between the constant voltage and the modulated superimposed voltage in apparatus comprising a field substantially excited by the constant voltage and a coil substantially traversed by a current caused by the said modulated superimposed voltage.

The invention is further characterized by a special device for generating the superimposed signaling voltage, a device consisting of an alternating current generator connected to the network and provided with a field winding, which is fed from one or a plurality of exciters, which have a D. C. wound armature, and a field winding connected in series with a condenser or an apparatus acting as a condenser.

According to one form of the invention, the apparatus serving to receive the signals are provided with contact devices mechanically tuned to the modulating frequencies of the superimposed signaling voltage.

The invention will be readily understood by reference to the accompanying drawings whereon:

Fig. 1 shows a set of machines for a generator imposing a modulated signaling voltage on the network.

Fig. 2 shows a modified set of machines for generating such a signaling voltage.

Fig. 3 is a vector diagram showing the different voltages of the machine set of Fig. 1.

Fig. 4 is a wave diagram showing the signaling voltage in relation to the constant voltage of the network.

Fig. 5 is a diagram showing the constant voltage and signaling voltage in the case where the modulating frequency is higher than the frequency of the normal voltage.

Fig. 6 shows a receiving relay used in the points of the network, where the signal voltage is comparatively high.

Fig. 7 shows a receiving relay used in those points of the network where the signal voltage variations have been damped and replaced by corresponding changes in the current.

Fig. 8 is a vector diagram showing the different voltages acting in the receiving relay of Fig. 6.

Figs. 9 and 10 are wave diagrams explaining the action of the relay of Fig. 6.

In Fig. 1, 1 is the network and 2 is a synchronous machine or a stationary transformer, connected to the network 1 giving a voltage opposing the line voltage. In the case where 2 is a rotating synchronous machine, 2′ designates the field winding of this machine, which is fed in known manner from a direct current source. This current is then of such a magnitude, that the voltage generated in the synchronous machine is equal to and opposing the voltage of the network. In the neutral point of the machine or transformer, which is opened, another transformer 3 is inserted. The winding 4 of this transformer 3 is connected to the neutral point and may be shunted by a switch 5, when no signals are to be sent out. The other winding 6 of the transformer 3 is connected to the armature winding 7 on an alternating current machine 8, which is started by a direct current electric motor 9. The excitation winding 10 of the machine 8 is connected in series with a direct current generator 11, which latter has for its purpose to compensate the armature reaction in the machine 8, and is in series with two special alternating current generators 12 and 13, to accomplish the necessary modulation. In the case of a signal voltage modulated with only a single frequency one of these machines of course may be omitted, and the diagrams, Figs. 3, 4 and 5, on the drawings refer to the case where the signal voltage is modulated with only a single frequency. The machines 12 and 13 consist of armatures with commutators and direct current windings movable in the fields of laminated magnets which are excited by the excitation windings 14 and 15 respectively. These field windings are connected in series with condensers 16 and 17 respectively. When the machines are out of function the switches 18 and 19 are open and the condensers 16 and 17 are maintained charged over the resistances 20 and 21 from the same direct current source which feeds the motor 9. The charging circuits for the condensers 16 and 17 are the following: the + terminal on the field winding of generator 9, resistances 20 or 21, condensers 16 or 17, field windings 14 or 15, armatures of machines 12 or 13, common terminal for switches 18 and 19, back to the — terminal of the field winding of generator 9. These switches 18, 19 are also used for determining the beginning and end of the signal impulses, but other means may also be provided for this purpose.

When the switches 18 and 19 are closed the windings 14 and 15 and the armatures of the machines 12 and 13 are traversed by currents from the condensers 16 and 17, and these currents continue as alternating currents with frequencies determined by the capacity of the condensers and the reactance of the field windings. These currents cause voltages in the armatures of the machines 12 and 13 respectively with the same frequencies as the frequencies of the currents in the windings 14 and 15. These alternating voltages cause an alternating current through the field winding 10 of the machine 8 and the alternating voltage generated in the winding 7 by these currents is transmitted to the winding of the machine 2 over the transformer 3. The direct current generator 11 serves only the purpose of giving a constant direct current compensating the armature reaction from the winding 7.

In the arrangement shown in Fig. 2, 22 designates a machine for the generation of the signal voltage which is displaced 90° in relation to the network voltage. This machine consists of a stator with an alternating current winding 23 and a rotor 24 with 4 sliprings and a direct current winding. This machine is excited partly with a constant direct current from a direct current generator 25 which gives a field which in the stator winding gives rise to a voltage opposite to the line voltage and equal thereto. The machine is also partly excited with a modulated alternating current from the generators 26 and 27 which are of the same type as those described in connection with Fig. 1. The voltage from the generators 26 and 27 is led to the rotor 24 in two diametrically disposed points perpendicular to the two diametrically disposed points to which the generator 25 is connected. The current from these machines therefore gives rise to a field displaced 90° in space with respect to the field generated by the current from the generator 25. Hence the field excited by generators 26 and 27 induces a voltage in the stator winding 23, which is displaced 90° with respect to the line or network voltage. The machine 22 is started to synchronous speed by a motor 28.

In Fig. 3 the vector 30 represents the normal voltage of one of the phases of the network, and 31 is the current vector corresponding to this voltage. 32 is the voltage corresponding to the armature reaction in the machine 8, and 33 is a voltage induced in the machine 8 by the current from the generator 11. Over the latter voltage the modulated voltage induced by the current from the generators 12 and 13 is superimposed, said voltage being represented on the diagram by the vector 34. The resulting voltage on the network is represented by the vector 35. The vector 36 represents the active power which is taken from the net 1. By a variation of the size of this vector by a loading of the machine 8 by means of the machine 9 the vectors 33 and 34 may be turned until they become perpendicular to the vector 30. In most cases such a turning is not necessary.

As seen in the diagram Fig. 3 a variation of the size of the vector 34 signifies a change of the phase angle between the vectors 30 and 35. If the change in size of the vector 34 is periodic and if the vector 30 has a constant angular speed the change of the size of the vector 34 is equivalent to a periodical variation of the angular speed of the vector 35. The vector 34 begins at the end of the vector 36 and alters between the limits designated by 34′ and 34″. The real meaning of this variation of the angular speed is illustrated by Fig. 4, which shows the variation of the signal voltage if it is modulated only in accordance with a simple sine curve. The curve 37 shows the alternating voltage on the network in the case that the vector 34 is zero. The curve 38 shows the resulting voltage, corresponding to the vector 35, in the case that the size of the vector 34 is altered in accordance with a low frequency. As may be seen from the diagram the voltage 38 is sometimes leading, sometimes lagging the voltage 37. The curve 38 thus varies between the limits given by the curves designated by 37′ and 37″. The curve 38*b* shows the superimposed signal voltage separated from the voltage of the network.

The diagrams Fig. 5 show the sine curves corresponding to the conditions when the modulation frequency is higher than the frequency of the voltage of the network and in these diagrams the voltage of the network when no signals are sent out is represented by the curve 37. The curve 38 represents the resulting voltage when signals are sent out. 39 represents the field of an electromagnet fed from the net, and 40 represents the modulated signal voltage. The curve 41 shows the force acting on a coil movable in the field 39 and traversed by a current caused by the voltage 40. Such a coil is for instance the relay coil 45 in the receiving relay shown in Fig. 6, and the curve 42*a* shows the change of the amplitude of the modulated signal voltage 40. The curve 42*b* shows the change of amplitude of the force curve 41.

The curve 42*a* varies between a positive and a negative value, and the physical meaning of this is that the voltage 40 changes its phase in the points A and B. The amplitude of the force-curve 41 varies also but between zero and a maximum value and the phase of this curve is always the same.

In Fig. 6 a receiving relay for the impulses is shown. This relay consists of an electromagnet 43 with coil 44. The coil 44 is connected in parallel with a condenser 60 of such a capacity that resonance in this circuit is reached for the frequency of the network voltage. The coil 44 and condenser 60 are connected to the net in series with a moving coil 45. This coil is rigidly attached to a rod or rib 46 which is suspended by a leaf spring 47 attached to its upper end. On the upper end of the rod 46 a beam 56 is fastened, and on this beam resonance weights 48 and 49 are attached by means of springs 50 and 51. The weights are provided with contacts 54, 55 and 57, 58, and between these contacts leaf springs 52 and 53 project, said springs being provided with contacts which cooperate with contacts on the weights 48, 49.

In Fig. 8, which is a diagram illustrating the function of the relay, the vector 61 represents the voltage on the relay. This voltage causes a current through the coils in the relay. 62 represents the current through the coil 44 which with respect to the phase is nearly perpendicular to the voltage 61, and 64 represents the current through the condenser 60. The current 62 causes a field 63 in the magnet 43, and in this field the coil 45 is movable. The current 64 is directed in nearly opposite directions to the current 62, and the resultant of these two currents is the current 65 which traverses the movable coil 45.

When the frequency of the voltage 61 is varied (a variation of the angular speed of the vector 61) the size of the currents 62 and 64 is altered. An increase of the frequency causes a decrease of the current 62 and an increase of the current 64. A decrease of the frequency, on the contrary, causes an opposite alteration of the currents 62 and 64. This alteration of the size of the currents causes an alteration of the size and also of the phase position of the resulting current 65 through the coil 45. It is easily shown that only the component of the current 65, which is in phase with the field 45, causes a force on the coil 45, which varies with the modulation frequency of the signal voltage. The component of the current 65, which is in phase with the voltage 61, only causes a force on the coil 45, which varies with a frequency equal to the double frequency of the network voltage, the mean value of said force being zero.

In Fig. 9, 61 designates the voltage on the relay. The curve 63 is the field in the magnet 43 and 65 is the resultant current through the coil 45. The force acting on the coil 45 is equal to the product of the current 65 and field 63 and is shown by the curve 66 in Fig. 10. As seen from this figure a force is obtained, which varies from a positive maximum value to a negative. If the frequency of this variation of the force is the same as the resonance frequency of one of the resonance weights for example 48 is brought in oscillation so that the spring 52 is caused to touch contacts 54 and 55. The intermittent closing of the contacts may then be used in known manner for closing the circuit of auxiliary relays, which in turn may be used for different purposes.

In Fig. 7 another connection of the relay is shown. The condenser 60 and the coil 44 are also, in this case, connected in parallel and connected to the network, but the coil 45 is connected to the network by means of a current transformer 67. In parallel with the coil 45 there is connected a series resonance circuit, which has for its purpose to prevent or at least to decrease as much as possible the current through the coil 45, which resonance circuit is tuned to the same frequency as the voltage of the network. The current, however, which has the same frequency as the signal voltage, cannot to any considerable extent traverse this circuit but must traverse the coil 45. The function is in other respects the same as the function of the relay shown in Fig. 6.

Instead of providing the relay with special members in mechanical resonance at the modulation frequencies it may be advisable in cases when only one modulation frequency is used to tune the movable coil itself in mechanical resonance at the modulation frequency.

I claim as my invention:—

1. A system for electrical signaling or controlling over an electrical alternating current network, which comprises means for superimposing upon the voltage of the network an alternating voltage of the same frequency as the network voltage, means for modulating the superimposed voltage, and means for receiving the signals by a coaction between the network voltage and the modulated superimposed voltage in apparatus comprising a field excited by the network voltage and a coil substantially traversed by a current caused by the modulated superimposed voltage.

2. A system for electrical signaling or controlling over an electrical alternating current network, which comprises means for superimposing upon the voltage of the network an alternating voltage of the same frequency as the network voltage, means for modulating the superimposed voltage, means whereby the signals are received by a coaction between the constant voltage and the modulated superimposed voltage in apparatus comprising a field excited by the constant voltage and a coil substantially traversed by a current caused by the modulated superimposed voltage, and contact devices mechanically tuned to the modulating frequency or frequencies of the superimposed voltage attached to the coil traversed by the modulated circuit.

3. A system for electrical signaling or controlling over an electrical alternating current network, which comprises means for superimposing upon the voltage of the network a modulated alternating voltage of the same frequency as the network voltage, a generator for the said superimposed voltage connected to the network, at least one exciter for exciting the field of the said generator and consisting of generators with direct current wound armatures and with field windings connected in series with condensers, and means whereby the signals are received by a coaction between the constant voltage and the modulated superimposed voltage in apparatus comprising a field excited by the network voltage and a coil substantially traversed by a current caused by the modulated superimposed voltage.

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