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POWER LINE CARRIER CURRENT SYSTEM

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2 Sheets-Sheet 1

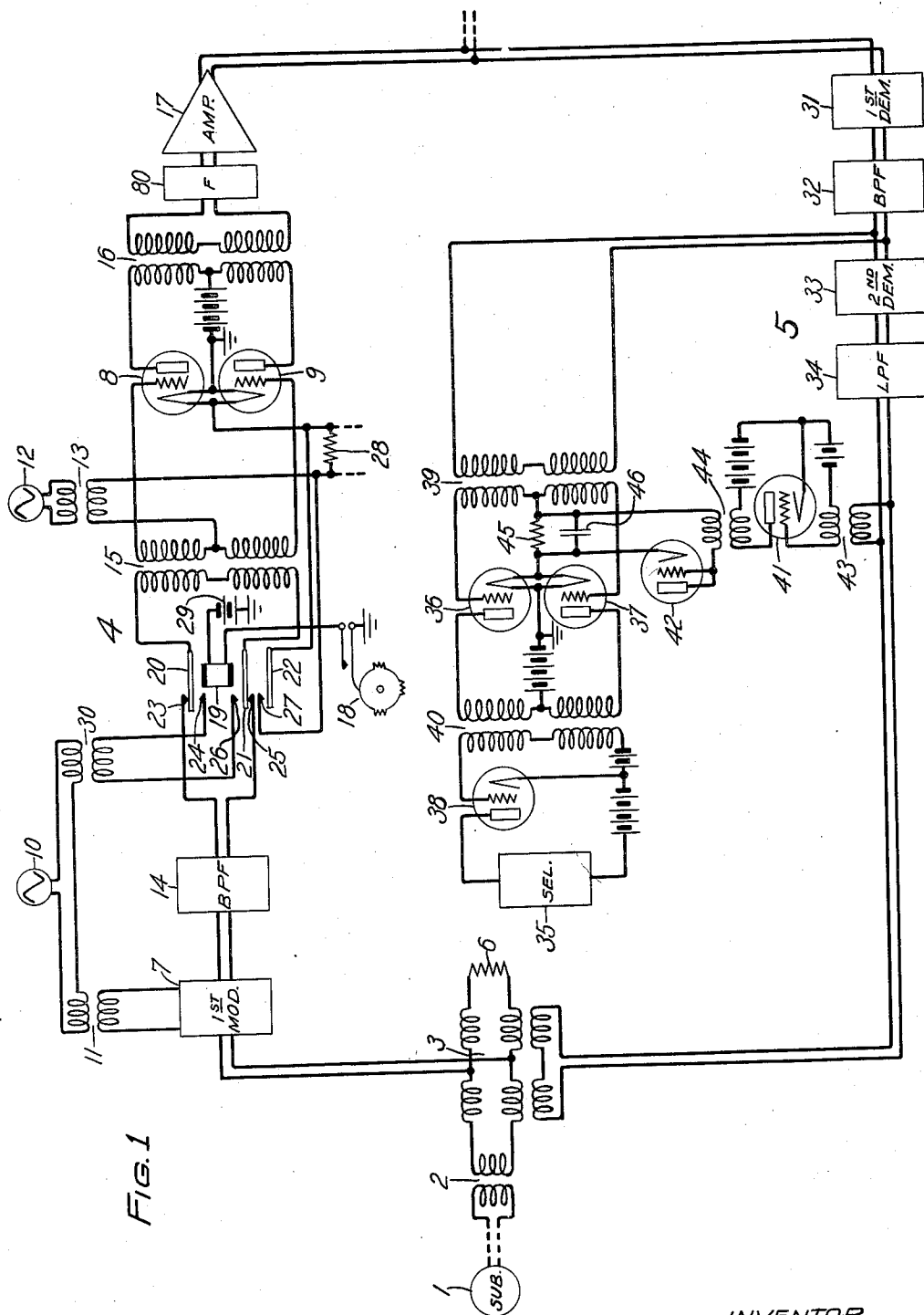


FIG. 1

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POWER LINE CARRIER CURRENT SYSTEM

Application filed August 10, 1929. Serial No. 384,878.

This invention relates to selective calling circuits and particularly to selective calling circuits for power-line carrier-current telephone systems.

One object of the invention is to provide a carrier-current telephone system with selective calling circuits that shall be operated by code signals of carrier current and be rendered inoperative when carrier current modulated with voice frequency currents is received.

Another object of the invention is to provide a carrier-current telephone system employing modulated carrier current for communication between stations with selective calling circuits that shall be operative for calling purposes when unmodulated impulses of carrier current are being transmitted and that shall be rendered inoperative for calling purposes when a carrier current modulated with a voice frequency current is received.

A further object of the invention is to provide a power-line carrier-current system employing modulated carrier current for communication between signal stations that shall have selective calling circuits for operating selectors at the signal stations by code signals of unmodulated carrier current and auxiliary circuits for rendering the calling circuits inoperative for operating the selectors when modulated carrier current is being transmitted over the power line.

In power-line carrier-current telephone systems a plurality of signal stations are connected to a power line carrying high-voltage low-frequency power currents. Communication between the signal stations is effected by modulated carrier current and provision is made whereby each station may selectively call any other station over the power line.

In the systems employed to disclose this invention communication is effected in both directions by the same carrier wave. One system which is employed to disclose the invention is disclosed and claimed in the patent to C. N. Nebel, No. 1,733,553, dated October 29, 1929. A second system which is employed to disclose the invention is disclosed and claimed in the application of J. D. Sarros, Serial No. 384,876, filed August 10, 1929. In the above mentioned patent to C. N. Nebel, the same carrier wave is employed for transmission in both directions and only one side band is transmitted over the power line during communicating between stations. In the

above mentioned application of J. D. Sarros, the same carrier wave is employed for transmission in both directions and the carrier wave and both side bands are transmitted over the power line during communication between stations.

Selective calling of a station in either of the above mentioned systems is effected according to this invention, by transmitting a code signal of unmodulated carrier current or carrier current modulated with a second carrier current to the called station. Provision is made to prevent operation of the calling circuit when any carrier current modulated with voice frequency currents is being transmitted over the power line.

In applying this invention to a power-line carrier-current telephone system wherein the carrier wave and both side bands are transmitted during communication between stations, provision is made in the transmitting channel at the calling station to transmit a code signal of unmodulated carrier current for operating a call selector at a called station. At the called station two amplifier tubes in push-pull relationship are connected to the receiving channel so as to be supplied with the high frequency modulated or unmodulated carrier current transmitted over the power line. The output circuits of the two amplifier tubes in push-pull relationship are connected to a thermionic rectifier which controls the operation of a suitable call selector. Provision is made for blocking and preventing operation of the two amplifier tubes except when unmodulated carrier current free from any modulation with voice frequency current is received over the power line.

In the system under consideration wherein the carrier wave and both side bands are transmitted over the power line, a detector tube is provided in the receiving channel for obtaining the voice frequency currents which have been modulated with the carrier wave. The voice frequency currents from the output circuit of the detector pass through a suitable low-pass filter and by means of an auxiliary control circuit comprising a thermionic amplifier apply a negative blocking potential to the grids of the above mentioned two amplifier tubes in push-pull relationship to each other. Thus whatever modulated currents are received over the power line, the thermionic amplifier tubes controlling the selector are blocked to prevent any

operation of the selector whatsoever. Accordingly, calling of the distant station can only be effected by transmitting code signals of unmodulated carrier current free from
5 any modulation with voice frequency currents.

If a single side band is transmitted over the power line for communication purposes as in the above mentioned patent to C. N. Nebel,
10 No. 1,733,553, selective calling in accordance with this invention is effected by transmitting a code signal comprising impulses of the first carrier current modulated with the second carrier current. In a system of the type disclosed in the application of C. N. Nebel,
15 Serial No. 282,810, two demodulators are provided in the receiving channel of each signal station. The output circuit of the first demodulator contains the lower frequency carrier wave and modulated products of this
20 lower frequency carrier wave with voice frequency currents. The two amplifier tubes in push-pull relationship which are connected to a rectifier for operating a selector
25 in accordance with this invention are connected to the output circuit of the first demodulator tube in order to be operated by the lower frequency carrier wave. Without additional blocking means it is apparent the selector
30 would be operated by impulses of the lower frequency carrier wave or by impulses of the lower frequency carrier wave modulated with voice frequency currents.

In order to prevent operation of the selector when communication between stations is being effected and voice frequency currents modulated with the low frequency carrier
35 appear in the output circuit of the first demodulator, an amplifier and a rectifier tube are connected to the output circuit of the second demodulator. The amplifier tube and the rectifier tube which are operated by the voice frequency currents in the output circuit
40 of the second demodulator apply a negative blocking potential to the grids of the two tubes in push-pull relationship which control the operation of the selector. Accordingly the selector at a called station in the system of the type under consideration can
45 only be operated when impulses of carrier current free from any modulation with voice frequency currents is received at the called station.

In the accompanying drawings

55 Figure 1 is a diagrammatic view of a signal station provided with calling circuits constructed in accordance with the invention.

Figure 2 is a diagrammatic view of a modification of the invention.

Referring to Fig. 1 of the drawings, a signal station is shown which is adapted to be connected to a power line carrier current system of the type disclosed in the patent
65 to C. N. Nebel, No. 1,733,553. The signal

station is particularly adapted for operation in a power line carrier current system wherein double modulation is effected at the transmitting station and only one side band of the modulation products is transmitted to the distant station.

An operator's telephone set 1 is connected by a transformer 2 and a hybrid coil 3 to a transmitting channel 4 and receiving channel 5. The hybrid coil 3 is provided with the usual balancing network 6.

The transmitting channel comprises a first modulator 7 which is preferably of the thermionic type disclosed in the above mentioned patent to C. N. Nebel and a second modulator comprising thermionic tubes 8 and 9 connected in push-pull relationship to each other. An oscillator 10 which is preferably of the thermionic type is connected to the first modulator 7 by means of transformer 11 for supplying a carrier current of relatively low frequency to be modulated with the voice frequency current supplied to the first modulator tube. A second oscillator 12 is connected by transformer 13 to the input circuits of the thermionic tubes 8 and 9 which comprise the second modulator. The second oscillator 12 supplies the second modulator with a carrier current of relatively high frequency. A band pass filter 14 in the output circuit of the first modulator 7 is connected by a transformer 15 to the input circuits of the thermionic tubes 8 and 9. The output circuits of the thermionic tubes 8 and 9 are connected by transformer 16 and a filter 80 to a power amplifier 17. The power amplifier 17 is connected in the manner disclosed in the above mentioned patent to C. N. Nebel to the high tension power lines.

A code selector key 18 of any suitable type such, for example, as the master impulse transmitting device disclosed in the patent to J. C. Field, No. 1,354,814, dated October 5, 1920, is provided for operating a relay 19. The relay 19 is provided with three armatures 20, 21 and 22. The armature 20 in the released position engages a contact member 23 and in the operated position engages a contact member 24. The armature 21 in the released position engages a contact member 25 and in the operated position engages a contact member 26. The armature 22 in the operated position engages a contact member 27 for short-circuiting a resistance element 28.

When relay 19 is deenergized and the armatures 20 and 21 engage with the contact members 23 and 25, the first modulator 7 is connected through the band pass filter 14 and transformer 15 to the input circuit of the second modulator. Upon operation of the relay 19 from a battery 29 by the selector key 18, the armatures 20 and 21 engage the contact members 24 and 26 for connecting the first oscillator 10 through a transformer

30 to the input circuit of the second modulator. The armature 22 engages the contact member 27 for short-circuiting the resistance element 28.

5 The resistance element 28 is a part of the duplex control circuits shown and described in the above mentioned patent to C. N. Nebel, No. 1,733,553. When the receiving channel is in service or the station is idle, a potential is impressed upon resistance element 28 for placing a blocking negative potential on the grids of the thermionic tubes 8 and 9. The placing of a shunt circuit across the resistance element 28 insures against any blocking of the second modulator when a calling signal is being transmitted. The duplex control circuits for impressing potentials on the control resistance 28 is not a part of the present invention and a detailed description thereof is deemed unnecessary.

15 The receiving channel 5 comprises a first demodulator 31, a band pass filter 32, a second demodulator 33, and a low pass filter 34 which is connected by the hybrid coil 3 and the transformer 2 to the operator's telephone set 1. The demodulators 31 and 33 and the filters 32 and 34 are similar in construction and operation to like parts shown and described in the patent to C. N. Nebel, No. 1,733,553.

20 A selector 35 is provided for operating a suitable call signal (not shown). Two thermionic tubes 36 and 37 which are connected in push-pull relationship and a rectifier thermionic tube 38 are provided for operating the selector 35. The input circuits of the amplifier tubes 36 and 37 are connected by a transformer 39 to the receiving channel 5 at a point between the band pass filter 32 and the second demodulator 33. A transformer 40 is provided for connecting the amplifier tubes 36 and 37 to the rectifier 38.

25 A thermionic amplifier tube 41 and a rectifier tube 42 are provided for preventing operation of the selector 35 when communication is being effected with a distant station. The amplifier tube 41 is connected by a transformer 43 to the receiving channel 5 at a point beyond the low pass filter 34 so as to be operated by voice frequency currents. The rectifier 42 is connected to the amplifier tube 41 by a transformer 44 and impresses a potential across a resistance element 45 in the input circuits of the amplifier tubes 36 and 37. The resistance element 45 serves to impress a negative blocking potential on the grids of the amplifier tubes 36 and 37 to prevent the operation of the selector 35 when carrier currents modulated with voice frequency currents are received over the power line. A condenser 46 is connected across the resistance element 45 for smoothing out any ripples in the output circuit of the rectifier.

30 In the operation of the signal station shown

in Fig. 1 of the drawings, voice frequency currents from the operator's telephone set 1 are modulated with carrier current from the oscillator 10 by the first modulator 7. One side band of this modulation process is selected by the band pass filter 14 and transmitted to the second modulator comprising the thermionic tubes 8 and 9. The tubes 8 and 9 modulate the side band received from the first modulator with a carrier wave of relatively high frequency received from the oscillator 12. The output from the second modulator passes through a filter 80 for selecting one side band which is passed through the power amplifier 17 to the power line.

35 When it is desired to selectively call a distant station, the key 18 is operated for controlling the relay 19 in accordance with a code signal. The operation of the relay 19 selectively connects the oscillator 10 with the input circuit of the second modulator to transmit a code signal of impulses. The code signal transmitted over the power line consists of one side band obtained from modulating the carrier current from the first oscillator with the carrier current from the second oscillator. At this time, as before set forth, the first modulator is disconnected from the second modulator and a shunt circuit is connected across the resistance element 28 so as to insure against impressing any negative blocking potential on the grids of the modulator tubes 8 and 9 by the duplex control circuits disclosed in the patent to C. N. Nebel, No. 1,733,553.

40 When communication is being effected between two stations, the two amplifier tubes 36 and 37 are supplied by the transformer 39 connected to the output of the band pass filter 32 with current of the frequency of the oscillator 10. If no blocking potential were impressed upon the resistance element 45, such current would effect the operation of the selector 35 by means of the rectifier 38. At the same time, however, the amplifier tube 41 is supplied with voice frequency currents from the output of the low pass filter 34. The output from the amplifier tube 41 is rectified by the tube 42. The rectifier impresses blocking potential on the grids of the two amplifier tubes 36 and 37.

45 Thus during communication between the two stations, means are provided for insuring against any operation of the selector at any station.

50 If calling impulses of a side band produced by modulating the carrier wave from the first oscillator 10 with the carrier wave from the second oscillator 12, are received in the receiving channel 5 the amplifier tubes 36 and 37 and the rectifier tube 38 effect the operation of the selector 35. At this time no voice frequency currents are provided for operating the amplifier tube 41 and the rectifier tube 42 for impressing a negative

blocking potential on the grids of the amplifier tubes 36 and 37.

In Fig. 2 of the drawings a diagrammatic receiving circuit is shown for use in a system of the type disclosed in the application of J. D. Sarros, Serial No. 384,876, filed August 10, 1929. In a system of this type communication between two stations on the power line is effected by transmitting the carrier wave and both side bands and selective calling is effected by transmitting code signals of the carrier wave unmodulated with any voice frequency currents.

The receiving channel shown in Fig. 2 of the drawings comprises a band pass filter 50, which selects the carrier wave and the side bands which are characteristic of the system. The band pass filter 50 is connected to a detector 51 which is preferably of the thermionic type. The output circuit of the detector tube is connected through a low pass filter 52 to the operator's telephone set 53. The means connected to the receiving channel for operating the selector is similar in construction and operation to like means shown in Fig. 1 of the drawings. Accordingly, the same reference characters will be used in Fig. 2 to indicate like parts shown in Fig. 1 of the drawings.

When carrier current impulses free from any modulation with voice frequency currents are received, the amplifier tubes 36 and 37 and the rectifier 38 are operated for effecting operation of the selector 35. However, if any carrier current modulated with voice frequency current is received, the amplifier tube 41 and the rectifier 42 are operated for impressing negative blocking potential on the grids of the tubes 36 and 37 to prevent any operation of the selector.

Modifications in the systems and in the arrangement and the location of parts may be made within the spirit and scope of the invention and such modifications are intended to be covered by the appended claims.

What is claimed is:

1. In a power-line carrier-current signal system, a high-tension power line, a plurality of signal stations connected to said power line, means for communicating in opposite directions between stations by carrier current of one frequency modulated with voice frequency currents, control means for selectively calling a station by transmitting code signals of said carrier current free from modulation with voice frequency currents, and means at said stations responsive to the current employed for communication between stations for preventing operation of said control means during communication between stations.

2. In a power-line carrier-current signal system, a power line carrying low frequency power current, a plurality of signal stations connected to said line, means for communi-

cating in opposite directions between stations by a carrier current of one frequency modulated with voice currents, call means at each station responsive to a code signal of said carrier current, and means at each station responsive to carrier current modulated with voice frequency current for preventing operation of said call means.

3. In a carrier-current signal system, a transmission line, a plurality of signal stations connected to said line, means for communicating in opposite directions between stations by carrier current of one frequency modulated with voice frequency currents, calling means at each station for selectively calling a distant station by transmitting a code signal of said carrier current free from modulation with voice frequency currents, selector means at each station responsive to carrier current signals free from modulation with voice frequency currents, and means at said stations responsive to the current employed for communication between stations for preventing operation of said selector means during communication between stations.

4. In a carrier-current signal system, a signal station, means at said station for communicating with another station by modulated currents, selector call means at the station responsive to carrier current impulses free from modulation with voice frequency currents, and means responsive to carrier current modulated with voice frequency currents for preventing operation of said selector call means.

5. In a carrier-current signal system, a signal station, means at said station for communicating with another station by modulated currents, call means at said station, control means responsive to carrier current for operating said call means, and means responsive to carrier current modulated with voice frequency currents for preventing operation of said control means.

6. In a carrier-current signal system, a transmission line, a plurality of signal stations connected to said line, means for effecting communication in opposite directions between two stations by carrier current of one frequency modulated with voice frequency currents, means at each station for transmitting code signals of said carrier current free from modulation with voice frequency currents to selectively call another station, selectors at said stations, control means at each station responsive to a code signal of carrier current free from modulation with voice frequency currents for operating a selector, and means responsive to carrier current modulated with voice frequency currents for preventing operation of said control means.

7. In a power-line carrier-current signal system, a power line having a plurality of signal stations connected thereto, means at

said stations for effecting communication in opposite directions by carrier current of one frequency modulated with voice frequency currents, means at said stations for calling by said carrier current free from modulation with voice frequency currents, selectors at said stations, control means at said stations responsive to carrier current free from modulation with voice frequency currents for operating said selectors, and means responsive to carrier current modulated with voice frequency currents for preventing operation of said control means.

8. In a power-line carrier-current signal system, a power line having a plurality of signal stations connected thereto, means for communicating between stations by modulated carrier current, call means at said stations, control means at said stations responsive to carrier current for operating said call means, and means at said stations responsive to modulated carrier current for preventing operation of said control means.

9. In a carrier-current signal system, a transmission line, a signal station connected to said line, means at said station for communicating over said line by modulated carrier currents, a selector at said station, means comprising a three-element thermionic amplifier tube for operating said selector by impulses of carrier current received at said station, and means operated when modulated currents are received at said station for applying a negative blocking potential to the grid of said amplifier tube to prevent operation of said selector.

10. In a carrier-current signal system employing the same carrier current wave for transmission in both directions, a transmission line, a signal station having a transmitting and a receiving channel connected to said line, means in said transmitting channel for transmitting modulated carrier waves for communicating with another station and for transmitting a code signal of unmodulated carrier current to selectively call another station, means in said receiving channel for demodulating the currents employed in communicating with a distant station, a selector, control means governed by the carrier current transmitted to said receiving channel for operating said selector, and means operated by the demodulation products in the receiving channel for preventing operation of the selector by said control means when modulated carrier current is received.

11. In a carrier-current signal system, a signal station having a receiving channel, two series related demodulating means and a low pass filter in said channel, a selector at said station, control means governed by the output from the first demodulator for operating said selector, and means connected to said

filter and operated by low frequency output from the second demodulator for preventing operation of said control means.

12. In a power-line carrier-current system, a power line carrying high voltage low frequency power currents, a signal station having a receiving channel connected to said power line, two series connected demodulator tubes in said receiving channel and adapted to demodulate currents which have been twice modulated, a selector, control means for operating said selector by the output from the first demodulator, and means operated by the low frequency output from the second demodulator for preventing operation of said control means.

13. In a power-line carrier-current system, a power line carrying high-voltage low-frequency power currents, a signal station connected to said power line, means at said station for communicating with another station by high frequency modulated currents, a selector at said station, control means responsive to high-frequency carrier-current for operating said selector, and means responsive to modulated carrier current for preventing operation of said control means.

14. In a carrier current signal system employing the same carrier wave for communication in opposite directions, a signal station having a transmitting and a receiving channel, two series-related modulators and two oscillators in said transmitting channel for effecting two modulating operations with the voice frequency currents during communication with a distant station, means for modulating current from the first oscillator with current from the second oscillator for transmitting a code signal of one side band, two demodulators and a low pass filter series connected in said receiving channel, a selector at said station, control means operated by the output from the first demodulator for operating said selector, and means connected to the output circuit of said filter and operated by the low frequency output from the second demodulator for preventing operation of said control means when modulated currents are received.

15. In a carrier current signaling system, a signal station, means at said station for communicating with a second station by modulated currents, call means at said second station, control means at said second station responsive to carrier current received from said first station for operating said call means, and means at said second station responsive to modulated current received from said first station for preventing operation of said control means.

In witness whereof, I hereunto subscribe my name this 9th day of August, 1929.

CHARLES N. NEBEL.