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SIGNALING SYSTEM

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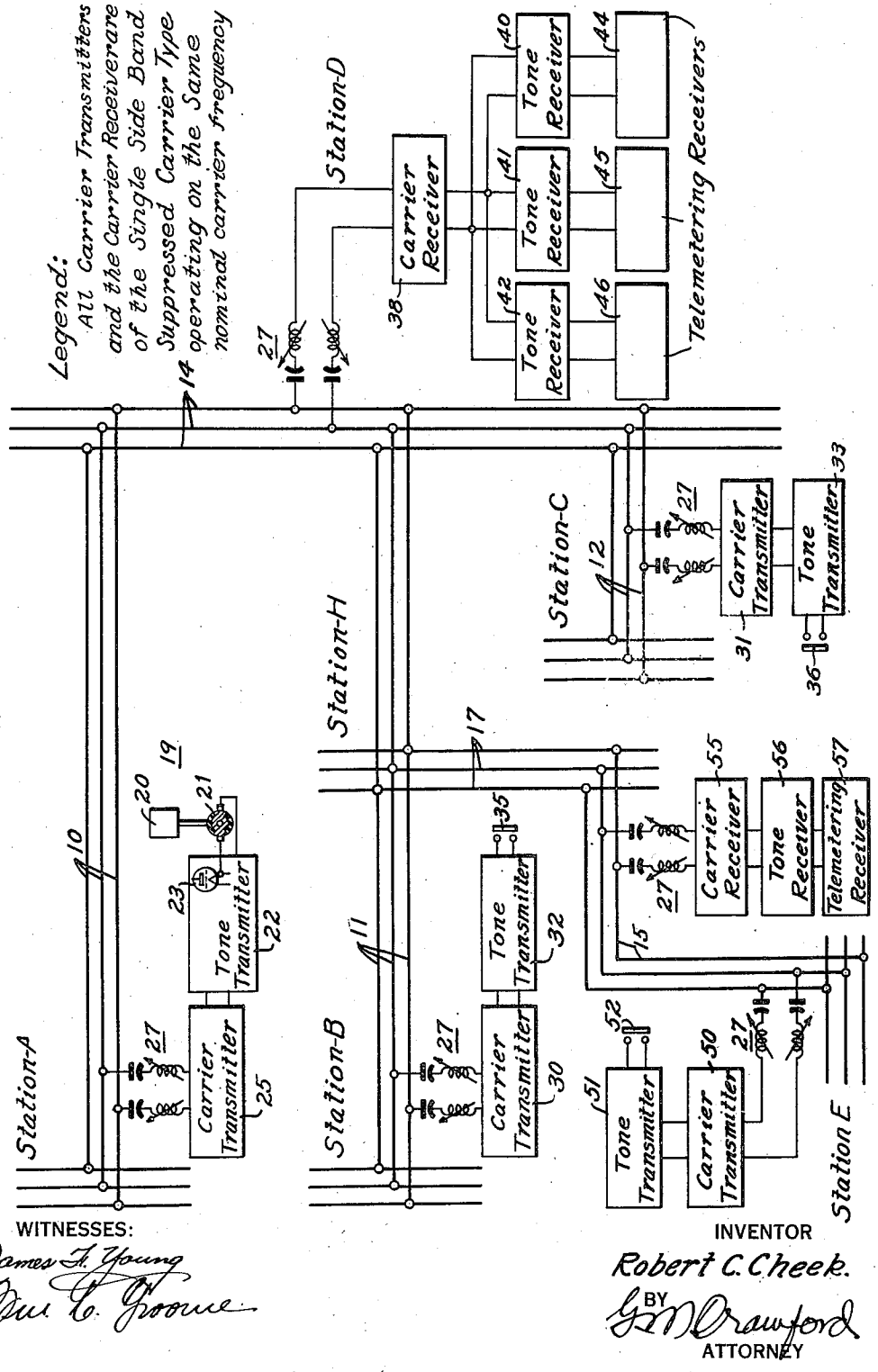

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SIGNALING SYSTEM

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My invention relates, generally to signaling systems, and has reference in particular to remote metering and load control signaling systems.

Generally stated, it is an object of my invention to provide a signaling system which is simple and inexpensive to manufacture and is easy to operate.

More specifically, it is an object of my invention to provide for transmitting signals of different audio frequencies over the same or different portions of a power system on the same nominal carrier frequency with a minimum of interference.

An important object of my invention is to provide for simultaneously transmitting and receiving between different sets of transmitting and receiving stations signals of several different frequencies over interconnected portions of a power system.

Another object of my invention is to provide for using a single suppressed-carrier single sideband carrier receiver in conjunction with a plurality of audio tone receivers, each responsive only to a particular tone frequency for receiving signals simultaneously from several points in a system.

Yet another object of my invention is to provide for preventing corona interference with carrier communication by using suppressed-carrier transmission.

Still another object of my invention is to provide for reducing the width and number of the frequency chanels required for transmission of telemetering and load control impulses in signaling systems.

It is also an object of my invention to provide separate signaling channels in a system on the same nominal carrier frequency.

Other objects will, in part, be obvious and will, in part, be explained hereinafter.

The usual application of telemetering on power systems involves the transmission to a central point (usually a dispatching office) of indications of power flow or other quantities from widely separated points or remote stations on the system. When carrier channels are used to transmit telemetering impulses from remote stations or interconnection points in the system, several such channels, each of a different carrier frequency, may terminate at a common point, which may be the dispatching office itself, or a relaying point which coordinates the several sets of impulses for retransmission on a single carrier frequency. When more than one quantity is to be telemetered over a single carrier channel, a separate tone frequency, modulating the carrier wave, is used for each quantity.

In the ordinary double side-band amplitude-modulation system of carrier transmission with tone telemetering, a continuous carrier wave is transmitted whether the tone modulation is present or not. The presence of this continuous carrier wave makes it necessary to use a different carrier frequency for each channel which terminates at a given point, and also usually requires the use of a different carrier frequency for every carrier channel on the power system, since the conductors are usually all interconnected at one or more points. These requirements are imposed by the fact that the presence at a receiving point of two or more carrier waves of slightly different frequencies gives rise to beat note interference, thus producing at the output of the receiver audio voltages which may cause tone receivers to operate and give false telemetering indications. Furthermore, if one of the carrier waves is appreciably stronger than the other, the stronger one will control the sensitivity of the receiver through the automatic volume control circuits usually provided, and the weaker signals may not be received.

The use of a different carrier frequency for each channel, as described above, leads in many cases to crowding the frequency spectrum available for power-line carrier purposes. This has become a serious problem on many power systems. Furthermore, even though several channels terminate at a common point, a separate carrier receiver is required for each, which thus multiplies the equipment necessary for the operation of the different channels.

In accordance with my invention, suppressed-carrier single side-band carrier transmitters, all on a common nominal carrier frequency, are used in conjunction with tone transmitters producing different suitable tone frequencies at a plurality of points or stations for transmitting telemetering or load control impulses over a channel or channels on common or connected portions of the power system. The carrier frequency is supplied locally at a receiving office by a suppressed-carrier single side-band receiver which is used to operate tone receivers. Each tone receiver is selectively responsive to only one of the different tone frequencies which it is desired to receive at the particular point in the office.

For a more complete understanding of the nature and scope of my invention, reference may be made to the following detailed description

which may be studied in connection with the accompanying drawing, in which the single figure is a diagrammatic view of a signaling system embodying the invention in one of its forms.

Referring to the single figure of the drawing, the numerals 10, 11 and 12 may designate the conductors of a power system or the like connecting buses at remote stations A, B and C to a bus represented by the conductors 14 at a central or dispatching station D. The numeral 15 may designate conductors of the power system connecting a bus at a remote station E with a bus represented by the conductors 17 at station H, which interconnects with the conductors 11 between the stations B and D.

In order to provide for impulse signaling, such as, for example, telemetering, between the stations A, B and C and the dispatching station D with a minimum of equipment and a maximum of efficiency, transmission of the signaling or telemetering impulses may be effected by using suppressed-carrier single side-band carrier transmitters of the same nominal frequency at each of the remote stations. For example, as shown in connection with station A, an impulse producing device 19, comprising, for example, a watt-hour meter 20, operating a commutator device 21, may be provided for producing suitable impulse tones which may be of audio frequency by periodically keying a tone transmitter 22 through control of the cathode circuit of the oscillator tube 23 thereof. A suppressed-carrier single side-band carrier transmitter 25 may be coupled to the conductors 10 by a tuned coupling circuit 27 for operation under the control of the tone transmitter 22 for transmitting impulses produced by the impulse metering device to the dispatching station D. The tone transmitter may operate to produce an audio frequency F_1 which modulates the carrier transmitter producing a signal of frequency equal to either carrier frequency plus audio frequency or carrier frequency minus audio frequency.

In order to provide for transmitting signaling or telemetering impulses from the stations B and C as well as from the station A, the stations B and C may be provided with carrier transmitters 30 and 31 also of the suppressed-carrier single side-band type and which may be coupled to the conductors 11 and 12, respectively, by coupling circuits 27. The carrier frequencies may be the same as that used for station A. However, the tone transmitters 32 and 33 used in conjunction with the carrier transmitters 30 and 31, may each operate to produce tones, of frequencies different from that of the tone transmitter 22 and different from each other, in response to operation of their respective impulsing devices which may be represented by the contact means 35 and 36, respectively. For example, the tone transmitters 32 and 33 may produce tone frequencies F_2 and F_3, respectively.

At the dispatching station D, the tone impulses may be received by a suppressed-carrier single side-band carrier receiver 38 of a type well known in the art, wherein a carrier frequency substantially the same as that used at stations A, B, and C may be supplied locally. The carrier receiver 38 may be connected to the conductors 14 by a tuned coupling circuit 27 of a type well known in the art. Though only a single tone transmitter is shown at each of the stations A, B and C, a plurality of tone transmitters may be used at any station if desired.

In order to receive impulses from the stations A, B and C simultaneously, means such as the tone receivers 40, 41 and 42 may be provided for operation from the carrier receiver 38. Each of the tone receivers may be selectively responsive to only one of the tone frequencies F_1, F_2 and F_3 transmitted by one of the tone transmitters 22, 32 or 33, which result may be readily accomplished by means of suitable filtering circuits. Impulse-responsive means, such as telemetering receivers 44, 45 and 46 of any type well known in the art, may be connected to the tone receivers 40, 41 and 42, respectively, for selective operation in response to telemetering impulses transmitted from any one of the remote stations A, B and C.

As is often desirable, an additional signaling channel may be provided in a portion of the system interconnected with any of the conductors over which the telemetering impulses are being transmitted, such as, for example, the conductors 11 which extend from station B to the dispatching station D. In order to provide a separate signaling channel over the conductors 15 which extend from a remote station E to a station H, where the bus 17 may be interconnected with the conductors 11, suppressed-carrier single side-band transmission may be used over the conductors 15. For example, a suppressed-carrier single side-band carrier transmitter 50 on the same carrier frequency as used at stations A, B, and C may be connected to the conductors 15 at the station E by a tuned coupling circuit 27 for operation under the control of or modulation by a tone transmitter operating on a frequency F_4, different from any of the audio frequencies used in connection with the other remote stations. The tone transmitter may be used to transmit impulses, such as load control impulses or telemetering impulses, as desired, under the control of an impulse device represented by the contacts 52. At the station H at the interconnecting point, a suppressed-carrier single side-band carrier receiver 55 of the same nominal frequency may be coupled to the conductors 15, by means of a tuned coupling circuit 27, for operating a tone receiver 56 respective only to the tone frequency F_4 transmitted by the tone transmitter 51 at the remote station E. Suitable impulse operated means, such as load control means or a telemetering receiver 57, may be connected for operation from the tone receiver 56.

In the system hereinbefore described, the several single side-band suppressed-carrier transmitters at the different stations A, B, C and H transmit telemetering or load control impulses on a common nominal carrier frequency. Each transmitter is tuned to the same nominal carrier frequency, but for each telemetered quantity or load control signal, a different audio tone is used. All the transmitted signals are received at each receiving point on a single carrier receiver. The audio output of the receiver is applied to one or more audio tone receivers, each of which is sensitive to only one of the audio tones used at the transmitting points. Operation in this manner is possible because no carrier wave is actuallly transmitted and, therefore, there is no beat note interference, such as would be encountered in a similar system using ordinary amplitude-modulation equipment, and neither is there any elimination of weak signals by stronger ones, such as would be encountered in either frequency-modulation or amplitude-modulation systems.

Additional sayings in frequency channel space

may be made by permitting duplication of carrier frequencies for entirely separate channels on the same power system. For example, as has been hereinbefore described, signaling may be maintained between the stations E and H, independently of telemetering impulses or other signals between the stations A, B, C and D. This separate channel for telemetering or load control impulsing may be on the same nominal carrier frequency as the telemetering channels between the stations A, B, C and D. The only requirements for satisfactory operation are that separate tone frequencies be used for each distinct impulse channel, and that the strength of the desired signals at the receiving point be comparable to that of other signals which it may not be desirable to receive at that particular point.

From the above description and the accompanying drawing, it will be apparent that I have provided in a simple and effective manner for selectively signaling over the same or connected channels in power systems. A minimum of equipment is required, since all signals may be transmitted on a single nominal carrier frequency and only a single carrier receiver is necessary to receive a plurality of different signals at a single receiving point. Interference between different signals is reduced to a minimum since no carrier is transmitted and the production of beat note frequencies is thereby eliminated. Since no energy is absorbed in transmitting the carrier, most of the available energy may be put into transmitting the intelligence bearing side-band component. In addition, since only a single side-band is transmitted, the band width of the signal channel may be greatly reduced. The use of a single nominal carrier frequency for several different channels results in a great saving in space in the carrier-frequency spectrum.

Since certain changes may be made in the above-described construction, and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all the matter contained in the above description and shown in the accompanying drawing shall be considered as illustrative and not in a limiting sense.

I claim as my invention:

1. A signaling system for a plurality of remote stations and a common office in a system comprising, a suppressed-carrier single side-band carrier transmitter at each station having the same nominal carrier frequency, a single carrier receiver at the office for said frequency, a tone transmitter of a different frequency at each station for modulating the transmitter at said station, and a plurality of tone receivers, each responsive to only one of the different tone frequencies, operating from the office carrier receiver in response to tone signals from the remote stations.

2. In an impulse telemetering system for a plurality of remote points in a power system connected by power conductors to a common metering point, impulse metering means including an audio tone transmitter at each remote point having a different tone frequency, a suppressed-carrier single side-band carrier transmitter of the same nominal frequency at each remote point modulated by the tone transmitter, a common suppressed-carrier single side-band receiver operating on the nominal frequency at the common metering point, and impulse metering means including a plurality of audio tone receivers each responsive only to a different one of the tone frequencies operated from the common carrier receiver.

3. For use in signaling between different points over interconnected conductors of a power system, means including impulse tone transmitters of different audio frequencies at different points in the system, a suppressed-carrier single side-band carrier transmitter of the same nominal frequency coupled to the system conductors at each of the points and modulated by the tone transmitters, a single suppressed-carrier single side-band carrier receiver coupled to the system conductors at another point, and impulse responsive means including a plurality of tone receivers operating from the carrier receiver, each of said receivers being responsive to only one of the tone transmitter frequencies.

4. The combination with a power system having interconnected conductors connecting a plurality of points, of a plurality of signaling systems coupled to the conductors, each system having transmitting means including one or more suppressed-carrier single side-band carrier transmitters of the same nominal frequency modulated by tone transmitters of different frequencies for transmitting signals, and receiving means including a suppressed-carrier single side-band carrier receiver of the nominal frequency operating one or more tone receivers each responsive only to a different one of the tone frequencies for receiving said signals.

5. For use with a power system having interconnected load conductors connecting several points, a signaling system comprising, telemetering means including impulse metering devices at a plurality of the points, a suppressed-carrier single side-band transmitter of a given nominal frequency at each of said plurality of points coupled to the load conductors, a tone transmitter of a different audio frequency at each of the plurality of points controlled by the impulse metering device for modulating the transmitter to transmit impulse signals, a common suppressed-carrier single side-band carrier receiver at another point for receiving said signals, and a plurality of tone receivers each responsive to only one of the tone frequencies operated from the common carrier receiver, and another signaling system comprising, a single side-band suppressed-carrier transmitter of the same nominal carrier frequency at an interconnection point, means including a tone transmitter of a frequency different from any of those of the other signaling system modulating the transmitter to transmit impulse signals, and means including a suppressed-carrier single side-band receiver coupled to the conductors at another point and an audio tone receiver responsive to said different frequency for receiving the signals from the interconnection point.

6. A method of signaling between a plurality of points in a system having interconnected conductors which comprises, transmitting audio tone signals of different frequencies by single side-band suppressed-carrier transmitters of a common nominal frequency over the conductors from a plurality of points, and operating a plurality of selective audio tone receivers at another point from a common single side-band suppressed-carrier receiver of the common nominal frequency.

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