Jan. 1, 1929. 1,697,462

L. C. GRANT

WIRED WIRELESS SYSTEM

Filed Sept. 26, 1927

Fig. 1.

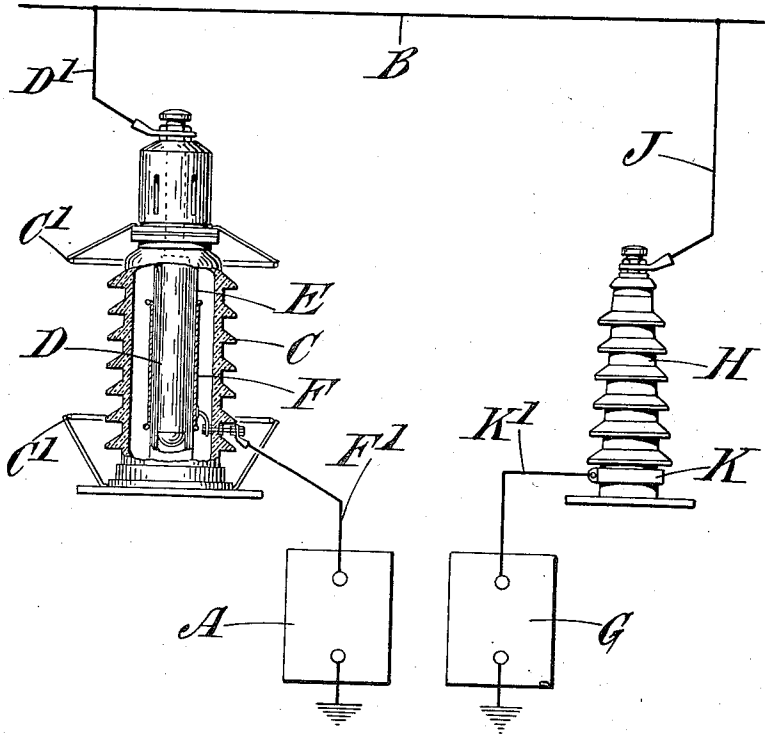
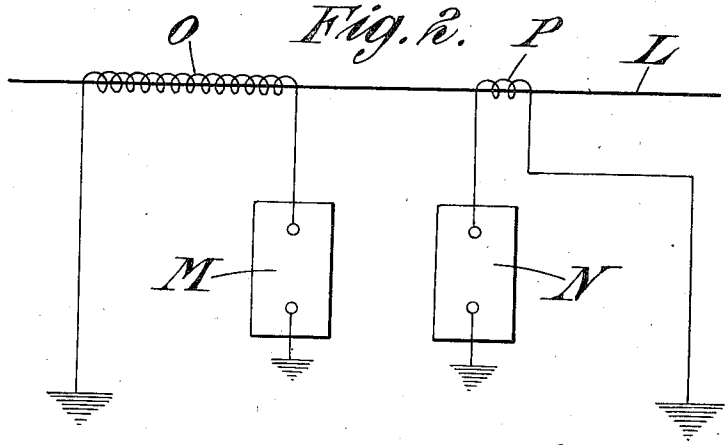


Fig. 2.



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UNITED STATES PATENT OFFICE.

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WIRED-WIRELESS SYSTEM.

Application filed September 26, 1927, Serial No. 222,088, and in Great Britain November 6, 1926.

This invention relates to wired wireless systems in which high frequency currents are transmitted over electric power lines or other conductors normally provided for other purposes. The invention is more especially concerned with wired wireless systems of duplex telephony, but is also applicable to telegraphic, remote control, protective and other systems arranged for duplex working, i. e. in which the high frequency currents are transmitted in both directions over a carrier conductor. It is to be understood that in some cases it may be convenient to employ more than one wire for carrying the high frequency currents. Thus for example the three wires of a three-phase electric distribution or transmission feeder may be coupled together in parallel (as far as the high frequency currents are concerned) so as to constitute a single carrier conductor. Again a carrier conductor consisting of a single wire or group of wires will usually be employed in conjunction with an earth return circuit, but this earth return circuit may, if desired, be replaced by another carrier conductor, which may also consist of a single wire or group of wires.

In wired wireless systems arranged for duplex working as hitherto employed, the transmitter and receiver at each end have been connected together and coupled to the carrier conductor (or to each carrier conductor) through a common coupling device, suitable means being provided for preventing the currents sent out from the transmitter from affecting the adjacent receiver and for preventing the received currents from being transmitted back again over the carrier conductor. The coupling devices may for instance take the form of condensers or transformers having such capacity or inductance or capacity and inductance as will enable the high frequency currents to be readily transmitted over the carrier conductor. The coupling devices must also be such as to prevent leakage of the power or other currents normally flowing in the carrier conductor, which would cause damage to the high frequency apparatus. It is found, however, with such arrangements, especially when a power line is employed as carrier conductor, that the noise produced in the receivers by the flow of atmospheric and induced currents as well as of the power (or other) currents in the carrier conductor causes very considerable interference with the operation of the high frequency system. This noise, which has a direct interfering effect in the case when the system is employed for telephonic purposes, is also indirectly a serious disability when the system is employed for other purposes. To overcome this difficulty it has been found necessary to increase the transmission power of the high frequency currents to a value many times greater than that which would be sufficient to give good signal strength if no interfering noise were present.

The present invention has for its object so to arrange a duplex wired wireless system that the trouble arising from the interference due to the power or other currents normally flowing in the carrier conductor is largely or wholly eliminated without appreciably increasing the transmission power of the high frequency currents or the sensitivity of the receiver.

In the system according to this invention the high frequency transmitting and receiving circuits at each end are coupled to the carrier conductor at different points, so that the branching point between these circuits lies on the carrier conductor side of the coupling devices, and the capacity or inductance of the coupling device associated with the transmitting circuit is at least ten times as great as the capacity or inductance of that associated with the receiving circuit.

Thus when an electric power line is employed as carrier conductor, in which case capacity coupling devices are usually preferable, the transmitting and receiving circuits are preferably connected to separate coupling devices located at different points of the power line, that associated with the receiving circuit being in the form of a condenser having relatively low capacity (for example between 0.0001 and 0.000001 microfarads), the actual value depending on the conditions of the particular installation. It is found that with this arrangement the interfering noise from the power currents can be reduced to one tenth of its previous amount or even less. Good results have been obtained with high frequency transmission

over power lines in one practical instance with the transmitter coupling device having a capacity of 0.0005 microfarads and the receiver coupling device having a capacity of 0.00001 microfarads.

A convenient practical form of coupling condenser for the transmitting circuit is that described in the specification accompanying the present applicant's United States patent application Serial No. 81,080, wherein the two electrodes, which are connected respectively to the power line and to the high frequency transmitting circuit, are enclosed within the interior of an insulating body constituting an insulator for the power circuit.

For the receiver coupling device a simpler construction of condenser may be employed. This may consist for instance of a metallic band or strip wrapped around the exterior of an ordinary power circuit insulator containing an electrode connected to the power line. Again the insulator which carries the band or strip may comprise a cylindrical body of insulating material strung on the power line. In another form the coupling consists of a small condenser of usual construction mounted on a power circuit insulator, the two electrodes being connected respectively to the power line and to the high frequency receiving circuit.

Preferably the two coupling devices are entirely separate from one another, but in some instances it may be convenient to employ a single insulating body to carry both devices. With such an arrangement however it is important that the distance separating the two electrodes, which are connected to the transmitter and the receiver respectively and are associated with different points of a conductor connected to or forming part of the carrier conductor, should be comparable with that existing when entirely separate insulators are employed. Generally speaking, it may be said that the best results are obtained when the electrodes and the connecting leads for the transmitter and receiver are so separated that there is no appreciable capacitative or inductive relationship between them.

The invention may be carried into practice in various ways, but two alternative arrangements according thereto are illustrated diagrammatically in the accompanying drawings, in which

Figure 1 shows an arrangement employing capacity coupling devices, and

Figure 2 illustrates the employment of transformers as coupling devices.

In each of the arrangements the drawings show one end of a duplex wired wireless system, in which the high frequency currents are transmitted over an electric power line with an earth return circuit.

In the arrangement of Figure 1 the high frequency transmitting apparatus diagrammatically represented at A is coupled to the power line B through a capacity coupling device of the kind forming the subject of the patent application Serial No. 81,080 above referred to. This coupling device comprises a hollow body C of insulating material which constitutes an insulator for the power circuit. Centrally disposed within the insulator C is a central conductor D connected at D^1 to the power line B and surrounded by an insulating sleeve E around which is provided a conducting sheath F connected by a lead F^1 passing through the wall of the insulator C to the high frequency transmitting apparatus A. Arcing rings C^1 are provided on the insulator in order that in the event of a flashover of the power current the high frequency apparatus will not be damaged. The interior of the insulator C is filled with oil and the coupling condenser formed by the conductor D and the sheath F is set to higher puncture and flashover standards than the external insulator. The capacity of this condenser is preferably of the order of 0.0005 microfarads.

The coupling device between the high frequency receiving apparatus G and the power line B is of simpler construction and consists of a power circuit insulator H containing a conductor connected to the power line by a lead J. A metal band K is wrapped around the outside of the insulator H at a position remote from the connection to the lead J and is connected to the receiving apparatus G by a lead K^1. The capacity of the coupling condenser formed by the band K and the conductor connected to the power line may be of the order of 0.00001 microfarads.

In the arrangement of Figure 2 the coupling devices between the power line L and the high frequency transmitting apparatus M and between the power line and the high frequency receiving apparatus N are in the form of transformers O and P respectively. The two ends of the secondary of the transformer O are connected to the transmitting apparatus M and to earth, and the secondary of the transformer P is similarly connected to the receiving apparatus N and to earth. Suitable values for the inductances of these coupling devices are 500 microhenries for the transformer O and 5 microhenries for the transformer P. In some cases it may be more convenient to employ two separate portions of a common secondary winding for coupling to the transmitting and receiving apparatus, but here again the degree of separation must be comparable to that when entirely separate transformers are employed.

What I claim as my invention and desire to secure by Letters Patent is:—

1. A wired wireless system arranged for duplex working, comprising a carrier conductor over which the high frequency cur-

rents are to be transmitted, high frequency transmitting and receiving circuits at each end of the carrier conductor, and coupling devices whereby the transmitting circuit and the receiving circuit are coupled to the carrier conductor at different points so that the branching point between these circuits lies on the carrier conductor side of the coupling devices, the coupling device associated with the transmitting circuit being capable of passing at least ten times as much high frequency energy as that associated with the receiving circuit.

2. A wired wireless system arranged for duplex working, comprising a carrier conductor over which the high frequency currents are to be transmitted, high frequency transmitting and receiving circuits at each end of the carrier conductor, and capacity coupling devices whereby the transmitting circuit and the receiving circuit are coupled to the carrier conductor at different points so that the branching point between these circuits lies on the carrier conductor side of the coupling devices, the capacity of the coupling device associated with the transmitting circuit being at least ten times as great as the capacity of that associated with the receiving circuit.

3. A wired wireless system arranged for duplex working, wherein high frequency currents are to be transmitted over electric power lines, including in combination at each end of the power line a high frequency transmitting circuit, a high frequency receiving circuit, a capacity coupling device between the receiving circuit and the power line in the form of a condenser having a capacity between 0.0001 and 0.000001 microfarads and a capacity coupling device between the transmitting circuit and the power line having a capacity at least ten times as great as that of the coupling device associated with the receiving circuit.

4. A wired wireless system arranged for duplex working wherein high frequency currents are to be transmitted over electric power lines, including in combination at each end of the power line a high frequency transmitting circuit, a high frequency receiving circuit, a capacity coupling device between the receiving circuit and the power line, and a capacity coupling device between the transmitting circuit and the power line comprising a hollow body of insulating material acting as an insulator for the power circuit, and two electrodes together constituting a condenser contained within the insulating body and respectively connected to the power line and to the transmitting circuit, the capacity of such coupling device being at least ten times as great as that associated with the receiving circuit.

5. A wired wireless system arranged for duplex working wherein high frequency currents are to be transmitted over electric power lines, including in combination at each end of the power line a high frequency transmitting circuit, a high frequency receiving circuit, a capacity coupling device between the receiving circuit and the power line comprising a conductor connected to the power line, a power circuit insulator surrounding such conductor, and a metallic band wrapped around the insulator and connected to the receiving circuit, and a capacity coupling device between the transmitting circuit and the power line having a capacity at least ten times as great as that of the coupling device associated with the receiving circuit.

In testimony whereof I have signed my name to this specification.

LEWIS COLIN GRANT.