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R. K. HONAMAN

CARRIER TRANSMISSION OVER POWER CIRCUITS

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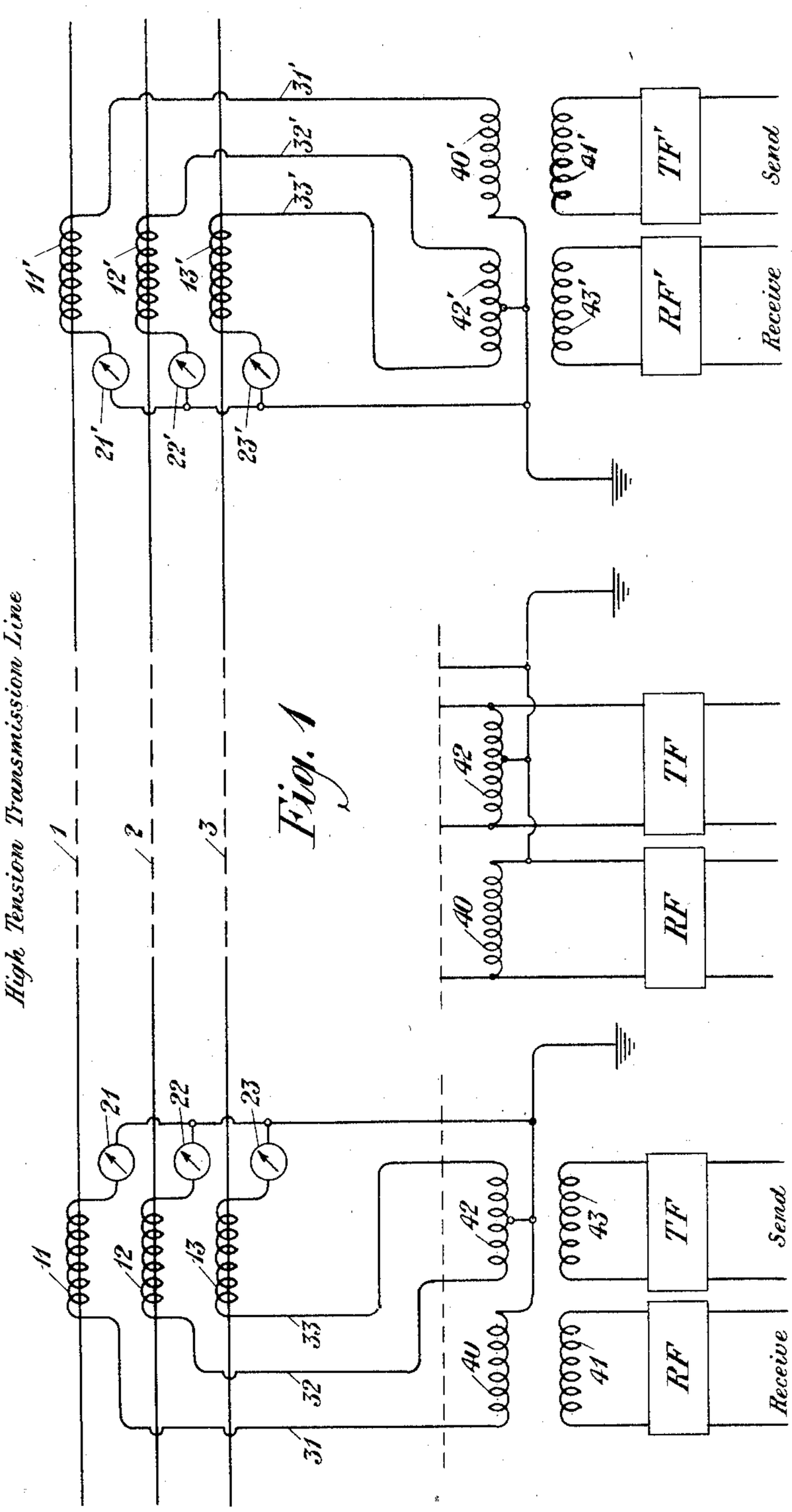

Fig. 1

Fig. 2

INVENTOR
R. K. Honaman
BY
ATTORNEY

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RICHARD K. HONAMAN, OF BLOOMFIELD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

CARRIER TRANSMISSION OVER POWER CIRCUITS.

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This invention relates to the use of power circuits for the transmission of signaling currents and more particularly to arrangements whereby carrier transmission channels may be related to the conductors of a power system.

In accordance with the present invention, advantage is taken of the fact that current transformers, which are ordinarily associated with a power system in order to step down the current actually transmitted to a value suitable for use with ordinary current measuring instruments, have such characteristics that although normally designed for the transmission of power frequencies they will efficiently transmit the much higher frequencies employed in carrier transmission. The carrier apparatus in accordance with the present invention is connected to the circuits containing the current measuring device, relays, or other translating devices through transformers which introduce very low impedances into the circuits at power frequencies. In order to obtain two signaling channels the transformers are so connected that one pair of the power conductors is used as a series metallic circuit for one channel, and a circuit consisting of the third conductor and the phantom of the first two is used for the other channel. Where different carrier frequencies are employed for transmitting in opposite directions the two channels may be used, one for transmitting in one direction and the other for transmitting in the other direction to constitute a two-way signaling circuit. Where, however, the carrier apparatus is so arranged that signaling may take place in both directions on the same carrier frequency, the two channels may be used to carry on two two-way telephone conversations at the same time or, if desired, one channel may be used for carrying on a telephone conversation and the other channel for auxiliary signaling.

The invention will now be more fully understood from the following description when read in connection with the accompanying drawing, the figures of which illustrate preferred embodiments of the invention. Referring to the drawing, 1, 2 and 3 designate respectively three conductors of a well known polyphase type of power distribution systems. In order to measure the current flowing over the power distribution system it is customary to connect measuring instruments, such as 21, 22 and 23, in circuit with each of three conductors 31, 32 and 33, which are inductively related through current transformers 11, 12 and 13 with the three conductors 1, 2 and 3 respectively of the power distribution system. The transformers 11, 12 and 13 are transformers which step down the current flowing through the measuring instruments to values appropriate for indication by the measuring instruments. The terminals of the three measuring instruments are ordinarily connected together and grounded through a conductor of substantially no resistance. At a distant point, similar current measuring apparatus may be provided, as indicated at the right-hand side of the figure, the various parts being designated by the same numerals as have already been referred to, the numerals, however, being primed.

In practice, the current transformers such as 11, 12 and 13 have their windings constructed with relatively few turns so that the distributed capacity is very small, and although these transformers are primarily designed for the transmission of power frequencies such as currents in the neighborhood of 60 cycles, they are quite efficient transformers at the much higher frequencies employed in carrier transmission. Consequently, in superposing a carrier channel on a power distribution system it adds greatly to the economy of the system to be able to utilize the current transformers for associating the carrier channel with the power conductors. In accordance with the present invention this result is accomplished by connecting the winding 42 of a transformer between the conductors 32 and 33, with a ground connection to the midpoint of the transformer, as shown. The other winding 43 of the transformer is connected in circuit with a channel leading to terminal carrier apparatus, the channel including the usual selective circuit, such as a filter TF. As a result of this connection the conductors 2 and 3 form the sides of a metallic transmission circuit, it being understood, of course, that similar transformer connections 42′ and 43′ are made at the distant station.

An additional channel may be provided by connecting the winding 40 of a transformer between the conductor 31 and the midpoint of winding 42, as shown, the secondary winding 41 being connected in the

terminal circuit leading to carrier apparatus. The terminal circuit may include a selective device, such as a filter RF. A similar connection comprising transformer windings 40′ and 41′ will, of course, be provided at the distant station.

It is essential that the introduction of the transformers in the current measuring circuits shall take place without substantially increasing the impedance at power frequencies. It may also be desirable, although not essential, to construct the transformers so that they are very inefficient at low frequencies while being quite highly efficient at the higher frequencies.

If the transformer comprising windings 42 and 43 be carefully balanced with respect to ground, the crosstalk between the two channels afforded by the transformer connections shown will be reduced to a minimum and the requirements of frequency selectivity between the circuits will thereby be reduced. Signals may be transmitted, therefore, through the filter TF and the transformer comprising windings 42 and 43 and thence over the conductors 2 and 3, forming a series metallic circuit to the receiving station, the signals being passed at the latter station through the transformer comprising windings 42′ and 43′ to the receiving carrier channel. Likewise, signals may be transmitted from the sending channel TF′ through the transformer comprising windings 40′ and 41′. The transmission path over the power conductors comprises in this case the power conductor 1, with a return over the power conductors 2 and 3 in parallel, owing to the connection of one terminal of the winding 40′ to the midpoint of the winding 42′. The signaling currents thus transmitted pass through the transformer comprising windings 40 and 41 and through the selective filter RF to the corresponding receiving channel.

It will be readily understood that instead of using transformers 40—41 and 42—43 to couple the carrier channels to the current transformer circuit, the coupling may be effected through retard coils 40 and 42 connected as shown in Figure 2. These coils should, of course, be designed to meet the requirement of low impedance at power frequencies.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a three-wire power distribution system, current transformers for associating each wire individually with a local circuit, a transformer having one winding serially connected between two of said local circuits and its other winding in a signaling circuit, a second transformer having one winding connected between the third local circuit and the midpoint of said first mentioned winding, the other winding of said second transformer being included in a second signaling circuit, said transformers being so designed that they introduce substantially no impedance at power frequencies.

2. In a three-wire power distribution system, a pair of stations interconnected through said three-wire system of conductors, current transformers at each station for individually connecting each wire of the three-wire conductor system to an individual local circuit, power translating devices in said local circuits, means to establish a metallic signaling path over two of said conductors comprising a transformer at one of said stations having one winding serially connected between two of said local circuits and its other winding connected to carrier signaling apparatus, a transformer similarly connected at the other station, means for establishing a second signaling path utilizing the third power conductor and the phantom of the first two power conductors, said means comprising a transformer at one station having a winding connecting the third local circuit to the midpoint of the winding of the transformer in the metallic circuit, the other winding of said transformer being in circuit with carrier signaling equipment, and means at the other station comprising a transformer similarly connected whereby signals may be independently transmitted over the power conductor system.

In testimony whereof, I have signed my name to this specification this 14th day of October 1924.

RICHARD K. HONAMAN.