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R. K. HONAMAN

CARRIER TRANSMISSION OVER POWER CIRCUITS

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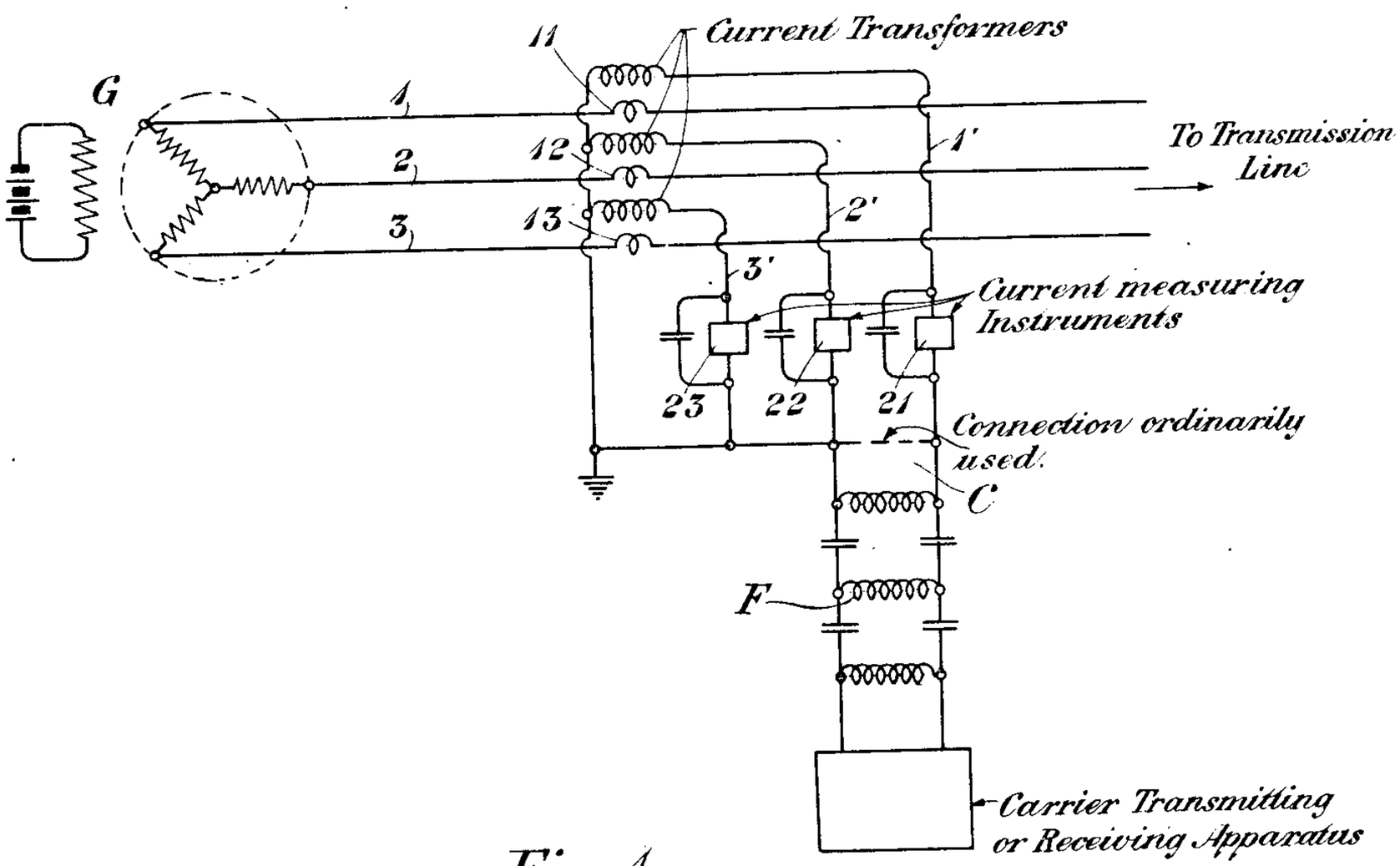

Fig. 1

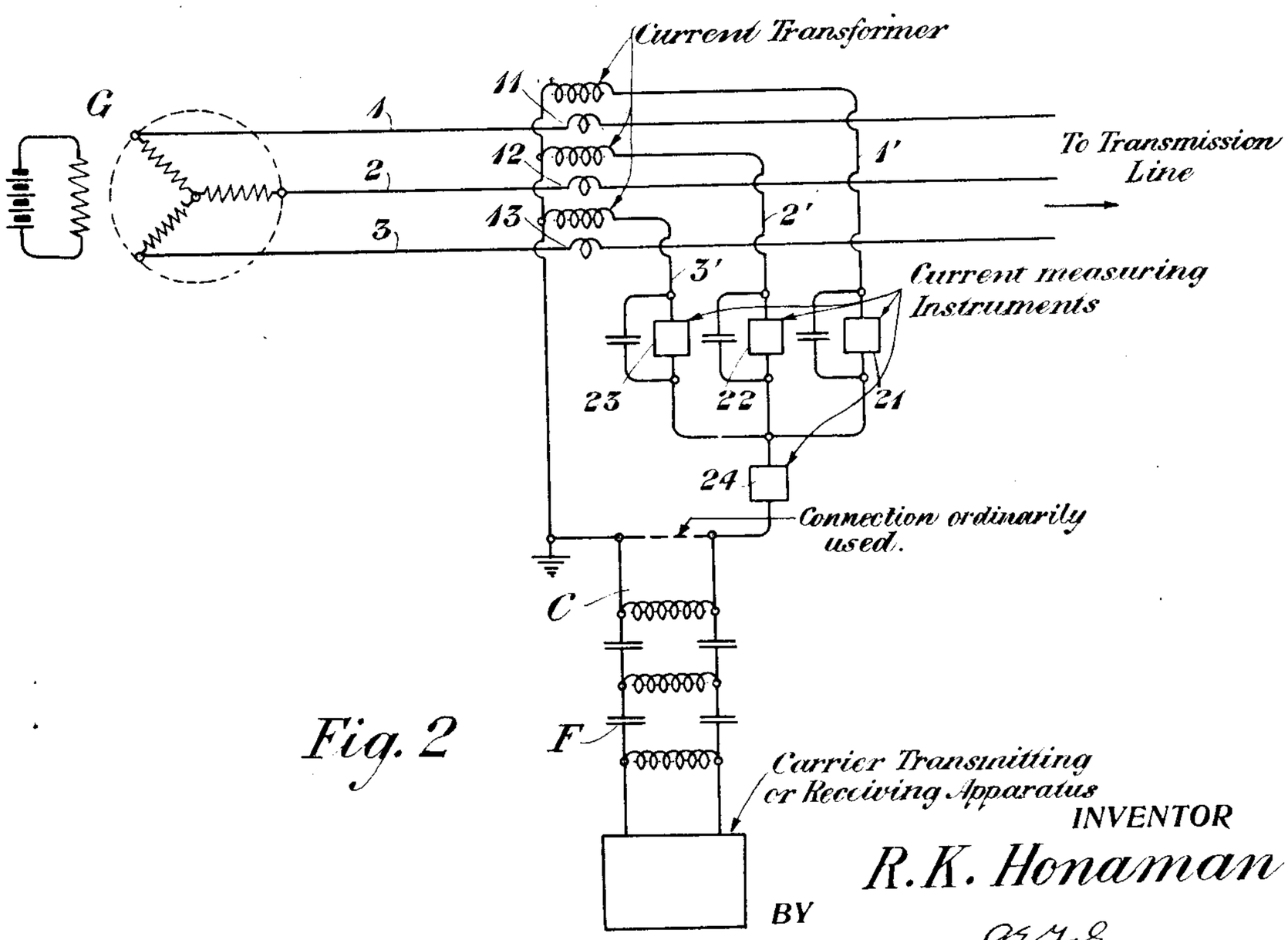

Fig. 2

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UNITED STATES PATENT OFFICE.

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

CARRIER TRANSMISSION OVER POWER CIRCUITS.

Application filed April 29, 1924. Serial No. 709,898.

To all whom it may concern:

Be it known that I, RICHARD K. HONAMAN, residing at Bloomfield, in the county of Essex and State of New Jersey, have invented certain Improvements in Carrier Transmission Over Power Circuits, of which the following is a specification.

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 the 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 is connected to the circuit which includes the current measuring or other translating device which is normally inductively connected to the power circuit, and in order to prevent any substantial increase in the impedance of the instrument circuit, the connection is made through a filter having a very low impedance at the power frequency and a considerably higher impedance at the carrier current frequencies.

The invention will now be more fully understood from the following description when read in connection with the accompanying drawings, Figures 1 and 2 of which illustrate two different arrangements embodying the principles of the invention. Referring to Fig. 1, G designates a power generator of the well known polyphase type having its star windings connected to the three conductors 1, 2 and 3 of the power distribution system in a well known manner. In order to measure the current flowing over the power distribution circuit, it is customary to connect measuring instruments such as 21, 22 and 23 in circuit with each of three conductors 1′, 2′ and 3′ which are inductively related through 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 normally connected together (as indicated by the dotted line connection in the figure) and grounded through a conductor of substantially no resistance as shown.

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 order to accomplish this result, the present invention contemplates opening the normal connection between two of the instrument circuits, for example, 1′ and 2′, and connecting the terminals of the carrier channel C to the two instrument terminals as indicated.

In order that this may be done without disturbing the measuring apparatus, the impedance looking into the carrier channel must be made very low for the power frequencies. The carrier channel may be made to have a very low impedance to the power frequencies if the high-pass filter F, which is included in the channel to suppress power frequencies and the lower harmonics thereof, is properly designed. The impedance looking into the filter is not greatly different from the impedance of the first section of the filter. Consequently if the filter is given a shunt termination, as illustrated, its impedance will be very low, for the shunt inductance element of the first section of the filter may be readily designed to offer a very low impedance to 60 cycle currents without changing the action of the filter in its range of free transmission. The power currents to be measured will therefore pass through the measuring instru-

ments and through the terminating shunt inductance of the filter without encountering an impedance substantially greater than that which would exist with the carrier channel not present.

In special cases where the impedance of the current measuring instruments such as 21, 22 and 23 happens to be large at carrier frequencies, it may be desirable to shunt these instruments by means of condensers, as indicated, to by-pass the carrier frequencies.

A modified arrangement is illustrated in Fig. 2 which differs from that of Fig. 1 in that one terminal of the carrier channel is connected to ground and the other terminal is connected to a conductor common to the three measuring circuits so that the carrier current will be transmitted over the three wires of the distribution system in parallel.

Normally the current measuring instruments will have their terminals joined together and the common terminal connected to ground, preferably through an additional measuring instrument 24, which measures the total current flowing in all three conductors of the distribution system. The carrier channel C may be connected to the circuit of the current transformers by opening the normal ground connection shown in dotted lines in Fig. 2 and connecting the terminals of the carrier channel into the circuit at the point where it is opened up. As in the case of Fig. 1, it is undesirable that any substantial impedance be introduced in the measuring circuit at the power frequency, and accordingly the filter is constructed to have a shunt termination. The terminal shunt inductance element of the filter, as already stated, may then have practically negligible impedance at the power frequency without changing the action of the filter at carrier 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 and scope of the invention as defined in the following claims.

What is claimed is:

1. In a system for signaling over power conductors, a power source, power conductors for transmitting power from said source to a load, current transformers associated with said conductors for transforming the current to be applied to translating devices, carrier apparatus, and means to connect said carrier apparatus to said power conductors through said current transformers, comprising a filter connected in circuit with said transformers and having a very low impedance at power frequencies.

2. In a system for signaling over power conductors, a power source, power conductors for transmitting power from said source to a load, current transformers associated with said conductors for transforming the current to be applied to translating devices, carrier apparatus, and means to connect said carrier apparatus to said power conductors through said current transformers, comprising a high-pass filter included in circuit with said transformers and having a shunt termination so that its impedance will be very low at power frequencies.

3. In a system for signaling over power conductors, a power source, power conductors for transmitting power from said source to a load, current transformers associated with said conductors for transforming the current to be applied to translating devices, carrier apparatus, and means to connect said carrier apparatus to said power conductors through said current transformers, comprising a high-pass filter having its terminals connected in circuit with said current transformers, said filter being so designed that its impedance at power frequencies will be very low.

4. In a system for signaling over power conductors, a power source, power conductors for transmitting power from said source to a load, current transformers associated with said conductors for transforming the current to be applied to translating devices, carrier apparatus, and means to connect said carrier apparatus to said power conductors through said current transformers, comprising a high-pass filter having its terminals connected in circuit with said translating devices, said filter having a shunt termination so that its impedance to currents of power frequency will be very low.

In testimony whereof I have signed my name to this specification this 26th day of April, 1924.

RICHARD K. HONAMAN.