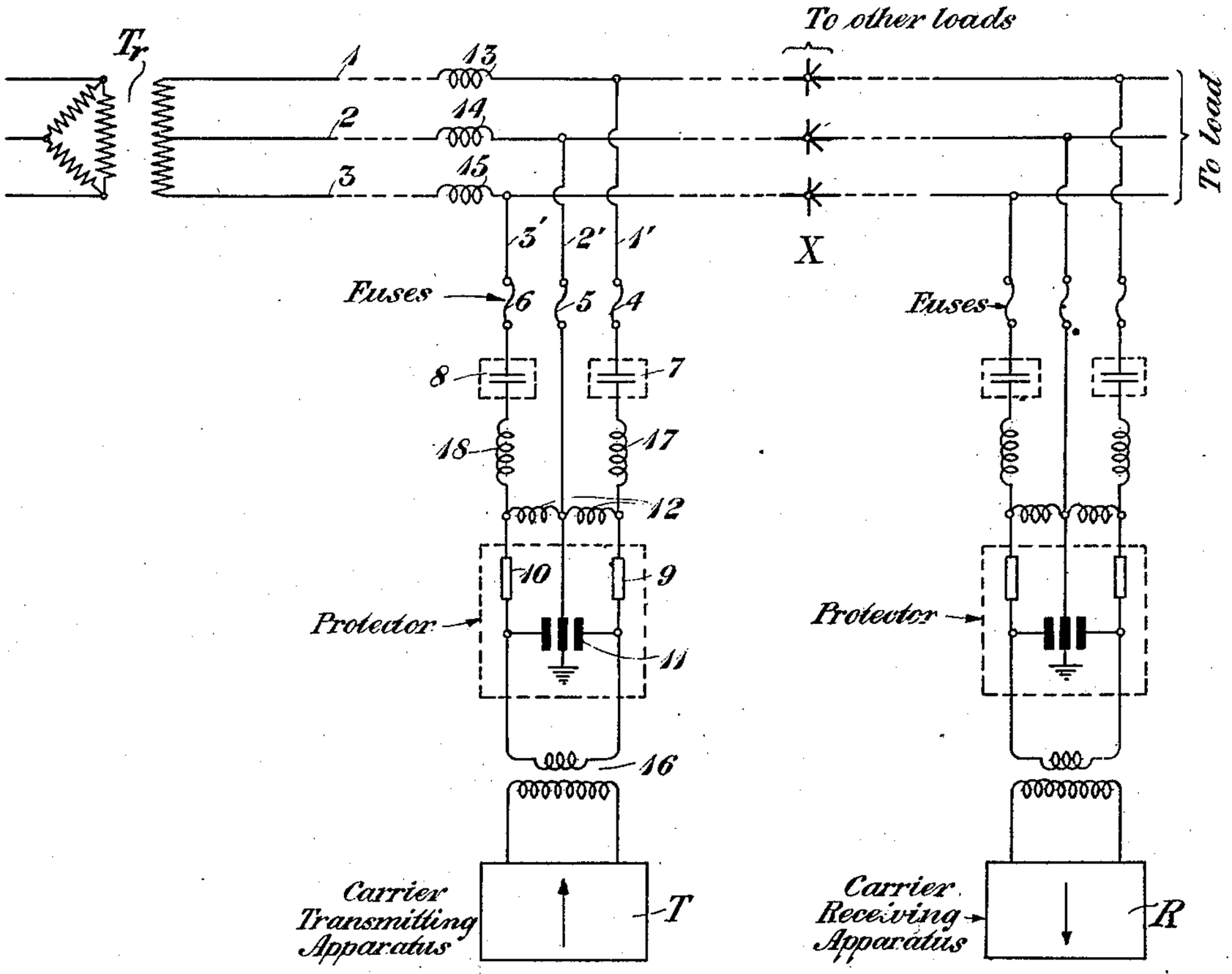
Nov. 23 , 1926. 1,607,668

C. H. FETTER

CARRIER TRANSMISSION OVER POWER CIRCUITS

Filed April 29, 1924



INVENTOR
C. H. Fetter

BY

ATTORNEY

Patented Nov. 23, 1926. 1,607,668

UNITED STATES PATENT OFFICE.

CHARLES H. FETTER, OF MILLBURN, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

CARRIER TRANSMISSION OVER POWER CIRCUITS.

Application filed April 29, 1924. Serial No. 709,901.

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 capacitatively related to the conductors of a power system.

In accordance with the present invention, a carrier channel is conductively connected to the conductors of a power circuit in such a manner that the carrier apparatus will be protected from the high voltages impressed upon the power conductors. The conductive connection is preferably obtained through a capacity coupling, the condensers forming the coupling being so designed as to offer a very large impedance at the relatively low frequencies employed in power transmission but being mechanically constructed so as to withstand the high power voltages of the power conductors. Between the condensers and the carrier apparatus an inductive shunt is connected across the carrier conductors to form a low impedance path for the low frequency currents employed in power transmission so that any current of power frequency passing through the condenser will be by-passed through the low resistance path.

If the condensers are designed to offer sufficient impedance at the power frequencies so that the voltage drop at this frequency through the by-pass will not be greater than it is desired to apply to the carrier apparatus, the impedance looking into the condensers at the carrier frequency will be much larger than that looking into the connection to the power conductors, unless the condensers are made so large mechanically that the expense would become prohibitive. Owing to this difference in impedance at the carrier frequencies, a large reflection loss would occur at the junction of the carrier channel with the power conductors, the impedance looking into the latter being quite low because of the large amount of copper employed and because of the numerous parallel branches which are involved in a power system. Accordingly it is proposed by the present invention to keep the condensers of a reasonable size mechanically and to neutralize the reactance of the condensers in part by means of inductances connected in series therewith, the inductances being so proportioned to the condensers that the impedance at the carrier frequency looking into the condensers will be substantially the same as that looking into the power system.

The invention will now be more fully understood from the detailed description thereof when read in connection with the accompanying drawing which illustrates a preferred embodiment of the invention.

Referring to the drawing, T_r designates a source of power energy, such, for example, as a multiphase transformer the windings of which are connected to the three power conductors 1, 2 and 3 in a manner well known in the art. In order to connect carrier transmission apparatus conventionally indicated at T to the power conductors, branch conductors 1′, 2′ and 3′ are provided. Condensers 7 and 8 are included in any two of the conductors 1′, 2′ or 3′, said condensers being illustrated in the conductors 1′ and 3′ in order to capacitatively couple the carrier apparatus T to the power conductors. In order that these condensers may withstand the high voltages impressed upon power conductors, their plates are made mechanically quite large and they are widely separated, special dielectric materials being also employed in a manner well known in the art. By thus designing the condensers, the amount of current flowing through the condensers at power frequencies will be relatively small. A by-pass 12, preferably inductive and having a very low impedance at power frequencies, will be connected across the conductors 1′ and 3′ in order to by-pass the power currents and thereby protect the carrier apparatus from such currents. The by-pass element should be designed to have a relatively high impedance at carrier frequencies.

Fuses 4, 5, and 6 are included in the conductors 1′, 2′ and 3′ in order to protect the carrier apparatus in case the power current flowing into the carrier channel should build up to a value greater than that for which it is designed. If desired, an additional protector may be included between the shunt 12 and the carrier apparatus. This protector may comprise fuses 9 and 10 included in the conductors 1′ and 3′ and a carbon block arrangement of well known type having its outer terminals connected to the conductors 1′ and 3′ while the third

conductor 2′ will be grounded through the inner block. The carrier apparatus T may be associated with the apparatus hereinbefore described through a step-down transformer 16 so that the impedance looking into the carrier apparatus through the transformer may thereby be made as low as desired.

As is well known, the conductors of a power system are branched to a plurality of different loads as indicated at X, and as a large amount of copper is employed in the conductors, it necessarily follows that the impedance at the carrier frequency looking into the power system from the terminals of the carrier channel will be quite low. The impedance looking into the carrier channel, on the other hand, will be quite high because of the mechanical limitations on the design of the condensers 7 and 8. The impedance looking into this circuit at the carrier frequency is, in effect, the series impedance of the condenser 7, the stepped down impedance of the carrier apparatus, looking through the transformer 16, and the impedance of the condenser 8. The shunt impedance of the by-pass 12 may be made so high at the carrier frequency that the by-pass 12 does not materially affect the transfer of energy of carrier frequency between the carrier apparatus and the power conductors. The impedance, looking into the carrier apparatus T, may be made as low as desired by means of the step-down transformer 16 so that the principal elements offering an impedance to the flow of the carrier current will be the condensers 7 and 8. In accordance with the present invention it is proposed to reduce the effective impedance of the condensers 7 and 8 at the carrier frequency by including in series therewith neutralizing inductances 17 and 18. The inductances 17 and 18 will be designed to neutralize a sufficient amount of the capacity of the condensers 7 and 8 at the carrier frequency so that the effective impedance looking into the carrier channel will be substantially equal to the impedance looking into the power network.

The condensers 7 and 8 and the by-pass 12 prevent the application of unduly large voltages of the power frequency to the carrier apparatus. For example, let us assume that the power current has a frequency of 60 cycles and that the voltage impressed upon the power conductors is 2700 volts. The condensers 7 and 8 offer such a large impedance at the power frequency that the current flowing through the by-pass 12 may be made normally about one-tenth of an ampere. If the impedance of the by-pass 12 at 60 cycles is 5 ohms, the normal power voltage across the terminals of the by-pass 12, and hence across the terminals of the carrier apparatus, will be about one-half of a volt. Suppose, now, one of the condensers, for example, the condenser 8, breaks down so that it is, in effect, short-circuited, the current flowing through the by-pass 12 will begin to build up rapidly until one of the fuses 4, 5 or 6 blows. If the fuse 6, for example, is designed to blow at 3 amperes, the current flowing through the inductance 12 would not build up to a value greater than 3 amperes, and hence the voltage drop across the terminals of the by-pass will only be 15 volts, which will not be in excess of that permissible for the carrier apparatus. Should the voltage build up, through the failure of the fuses 4, 5 and 6 to properly function, to too great a value, the current will be by-passed through the carbon block device 11, and one of the fuses 9 or 10 will blow.

The apparatus associated with a carrier receiving channel, as illustrated at the right of the diagram, will be in all respects similar to that above described, and no further reference thereto is necessary. If desired, choke coils 13, 14 and 15 may be included in the power circuit between the carrier terminals and the generator G to prevent transmission of the carrier frequencies to the generator.

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, carrier apparatus, means for coupling said carrier apparatus to said power conductors comprising condensers so designed mechanically as to withstand high power voltages, and means to partially neutralize the reactance of said condensers at carrier frequencies so that the impedance looking into the carrier channel may be made substantially the same as the impedance looking into the power network.

2. In a system for signaling over power conductors, a power source, power conductors for transmitting power from said source to a load, carrier apparatus, means for coupling said carrier apparatus to said power conductors comprising condensers so designed mechanically as to withstand high power voltages, a step-down transformer between the carrier apparatus and said condensers for stepping down the impedance of the carrier apparatus to an impedance lower than the impedance looking into the power network, and means for partially neutralizing the reactance of said condensers at the carrier frequency so that the impedance looking into the said condensers

and the carrier apparatus may be made substantially the same as the impedance looking into the power network.

3. In a system for signaling over power conductors, a power source, power conductors for transmitting power from said source to a load, carrier apparatus, means for coupling said carrier apparatus to said power conductors comprising condensers so designed mechanically as to withstand high power voltages, a step-down transformer between the carrier apparatus and said condensers for stepping down the impedance of the carrier apparatus to an impedance lower than the impedance looking into the power network, means for partially neutralizing the reactance of said condensers at the carrier frequency so that the impedance looking into said condensers and the carrier apparatus may be made substantially the same as the impedance looking into the power network, and a by-pass bridge across the carrier channel between said condensers and the carrier apparatus, said by-pass offering a very low impedance to power currents but having a very high impedance at the carrier frequency.

4. In a system for signaling over power conductors, a power source, power conductors for transmitting power from said source to a load, carrier apparatus, means for coupling said carrier apparatus to said power conductors comprising condensers so designed mechanically as to withstand high power voltages, a step-down transformer between the carrier apparatus and said condensers for stepping down the impedance of the carrier apparatus to an impedance lower than the impedance looking into the power network, means for partially neutralizing the reactance of said condensers at the carrier frequency so that the impedance looking into said condensers and the carrier apparatus may be made substantially the same as the impedance looking into the power network, a by-pass bridge across the carrier channel between said condensers and the carrier apparatus, said by-pass offering a very low impedance to power currents but having a very high impedance at the carrier frequency, and fuses included in the carrier conductors, said fuses being designed to open said conductors upon the flow of a power current sufficiently great to cause a voltage drop through said by-pass greater than that which it is desired shall be applied to the carrier apparatus.

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

CHARLES H. FETTER.