

March 3, 1936.

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POWER LINE CARRIER SYSTEM

2,032,360

Filed Dec. 12, 1930

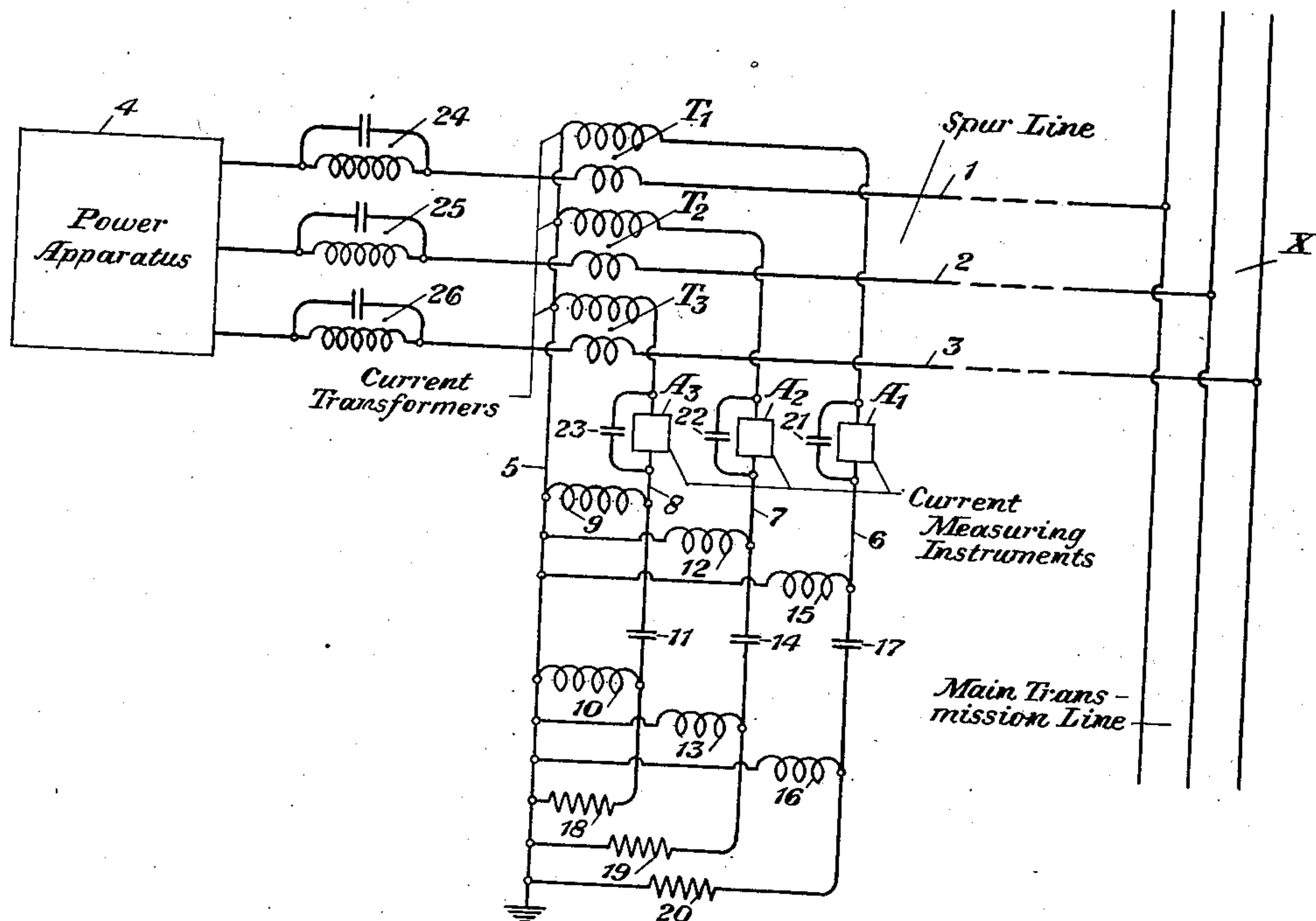


Fig. 1

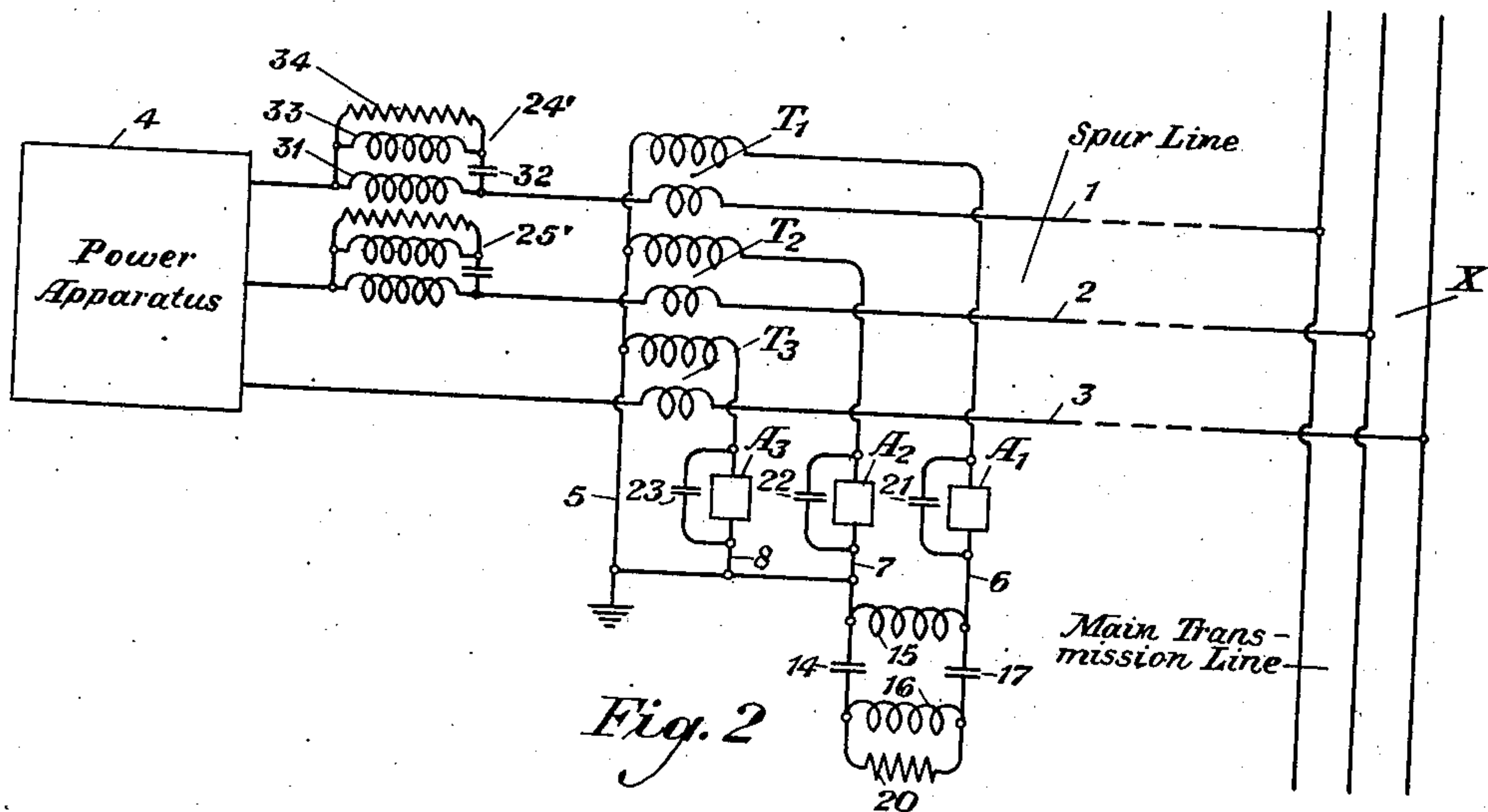


Fig. 2

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2,032,360

POWER LINE CARRIER SYSTEM

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Application December 12, 1930, Serial No. 501,985

4 Claims. (Cl. 177—352)

This invention relates to transmission of signals at carrier frequencies over power lines, and particularly to means for terminating the power lines at high frequencies.

As pointed out in the copending application of Affel and Green, Serial No. 501,984, filed December 12, 1930, a power line circuit is less well adapted for carrier communication than the ordinary telephone circuit, owing to the presence of apparatus upon the power line whose impedance may be low for the range of frequencies employed in carrier transmission. Because of such improper terminating impedances, and also for other reasons, the characteristics of a carrier circuit derived from a power line are extremely erratic as a function of frequency. In the said copending application there is described a network for terminating a power line at carrier frequencies, which network is designed to have the characteristic impedance of the line throughout the range of carrier frequencies employed. The arrangement therein shown is conductively bridged across the circuit to be terminated.

The present invention resides in a network for terminating a power line at high frequencies, which network is effectively connected with the system by utilizing a portion of the apparatus normally employed in the power system—namely, the current transformers that are connected with the power line for the purpose of measuring the magnitudes of the power currents flowing thereover.

This invention will be understood from the following description when read in connection with the attached drawing, of which Figure 1 shows schematically a network to terminate completely a three-phase transmission line at carrier frequencies, and Fig. 2 shows a modification of the invention for use in terminating a single phase carrier circuit derived from a three-phase power line.

In Fig. 1, 1, 2 and 3 represent the conductors of a three-phase spur line L, which is connected with the main transmission line at the point X. Connected with the spur line is power apparatus 4, which may be a generating station or a load that is supplied with power from a generating station connected with the distant end of the main line. Associated with the conductors 1, 2 and 3 at or near the station where the power apparatus 4 is located are the current transformers T₁, T₂ and T₃, having their primary windings connected in series with the said conductors. These transformers form part of the apparatus normally employed at a power station

for the measurement of the currents flowing over the transmission lines. The secondary winding of transformer T₁ is connected with a current measuring instrument A₁, and in like manner the corresponding windings of transformers T₂ and T₃ are connected with the instruments A₂ and A₃. Such instruments would normally be connected in series with the said secondary windings and ground to indicate the magnitudes of the currents flowing over the conductors of the line L. Since those current transformers have windings of relatively few turns, the distributed capacity is quite small, and consequently, they are quite effective transformers at carrier frequencies. In view of that fact, it is possible to employ those transformers to effectively connect with the said line the terminating network to terminate the said line at the carrier frequencies. This is accomplished by using a high pass filter structure with shunt termination. It will be seen that the left-hand terminals of the secondary windings of transformers T₁, T₂ and T₃ are connected to ground by conductor 5, and that the current measuring instruments A₁, A₂ and A₃ are connected to ground by the conductors 6, 7 and 8, respectively. Bridged across the conductors 5 and 8 are the inductances 9 and 10, between which is connected the condenser 11. In similar manner, the inductances 12 and 13 and condenser 14 are connected between conductors 5 and 7; and likewise, inductances 15 and 16 and condenser 17 are connected between conductors 5 and 6. The resistance 18 is shunted across inductance 10, resistance 19 across inductance 13, and resistance 20 across inductance 16. Condensers 21, 22 and 23 shunt the current measuring instruments A₁, A₂ and A₃, respectively, for the carrier frequencies.

The impedance networks 24, 25 and 26, that are connected in series with conductors 1, 2 and 3, respectively, of the spur line, serve to render the impedance high at carrier frequencies of that portion of the spur line looking toward the power apparatus. The combination of the terminating networks and the impedance networks, as shown in the spur line, provides a smooth termination of that line at carrier frequencies and thus eliminates an "impedance irregularity" in the system.

The use of the current transformers represents an economical arrangement for associating the terminating network with the said line. In the design or calibration of the current transformers, allowance can be made for the presence of such inductance as is included in series with them.

In addition to being of value in connection

with power line carrier systems, the terminating arrangement of Fig. 1 may be advantageously employed in reducing the effect upon a power system of transient currents that result from short circuits, lightning, etc. Since the arrangement effectively terminates the line in an impedance approximating its characteristic impedance, it prevents the building up of high potentials by resonance action when the line is shocked by transients, lightning, etc.

Fig. 2, in which the same reference numerals have been employed as in Fig. 1 to indicate similar parts, shows the application of the invention for terminating one phase of a three-phase transmission line for carrier frequencies transmitted thereover. In this case, however, the networks 24 and 25 have been replaced by networks 24' and 25', which are of the type disclosed in the copending application of Affel and Green. Each network comprises a π type filter section, having as one pillar the inductance 31, which is connected in series with the line conductor, as architrave the condenser 32, and as the other pillar the inductance 33, a terminating resistance 34 being shunted across the inductance 33. Such a network may be designed to give a constant impedance of suitable value at all frequencies above the critical frequency of the filter, while the inductance affords free passage to the power currents. In view of the description of the invention disclosed in Fig. 1, further explanation of Fig. 2 seems unnecessary.

While the invention has been disclosed as embodied in certain forms, it is to be understood that such showing is purely schematic, and that the invention is not limited except as defined by the appended claims.

What is claimed is:

1. In a system for the transmission of power currents, a multi-phase transmission line, each conductor of said line having connected in series therewith the primary winding of a current transformer, the secondary windings of said current transformers being connected to current measuring devices, a multi-phase wave filter connected in circuit with said measuring devices, said wave filter being terminated in resistances, and the arrangement and proportioning of said current transformers, current measuring devices, wave filter and terminating resistances being such as to present a low impedance for the frequency of said power currents, and being such as to terminate said transmission line at carrier frequencies in an impedance approximately equal to its characteristic impedance.

2. In a system for the transmission of power currents, a multi-phase transmission line, each conductor of said line having connected in series therewith the primary winding of a current transformer, all secondary windings of said current transformers having one terminal connected to a common conductor, an inductance connected

in series with a current measuring device between said common conductor and the other terminal of each current transformer, each of said current measuring devices being shunted by a condenser, said inductances forming part of a multi-phase wave filter, said wave filter being terminated in resistances, the combination of said current transformers, current measuring devices, wave filter and terminating resistances presenting a low impedance to said power currents and being so proportioned as to terminate said transmission line at carrier frequencies in an impedance approximately equal to its characteristic impedance.

3. In a system for the transmission of power currents, a multi-phase transmission line, each conductor of said line having connected in series therewith the primary winding of a current transformer, all secondary windings of said current transformers having one terminal connected to a common conductor, an inductance connected in series with a current measuring device between said common conductor and the other terminal of the secondary winding of each current transformer, each of said current measuring devices being shunted by a condenser, said inductances forming part of a multi-phase wave filter, said wave filter being terminated in resistances, the impedance presented by said wave filter at carrier frequencies being approximately equal to the characteristic impedance of said transmission line divided by the impedance transformation ratio of said current transformers.

4. In a system for the transmission of power currents, a multi-phase transmission line, each conductor of said line having connected in series therewith the primary winding of a current transformer, all secondary windings of said current transformers having one terminal connected to a common conductor, an inductance connected in series with a current measuring device between said common conductor and the other terminal of the secondary winding of each current transformer, each of said current measuring devices being shunted by a condenser, each of the said inductances being shunted by a condenser in series with another inductance and each of said other inductances being shunted by a resistance, the said inductances and intermediate condensers being so proportioned as to form a multi-phase wave filter capable of passing frequencies substantially higher than the frequency of said power currents, the impedance introduced in said transmission line by the combination of current transformers, current measuring devices, wave filter and terminating resistances being substantially low for the frequency of said power currents and being substantially equal to the characteristic impedance of said transmission line at frequencies substantially higher than the frequency of said power currents.

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