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ELIMINATION OF INTERFERENCE IN CARRIER SYSTEMS

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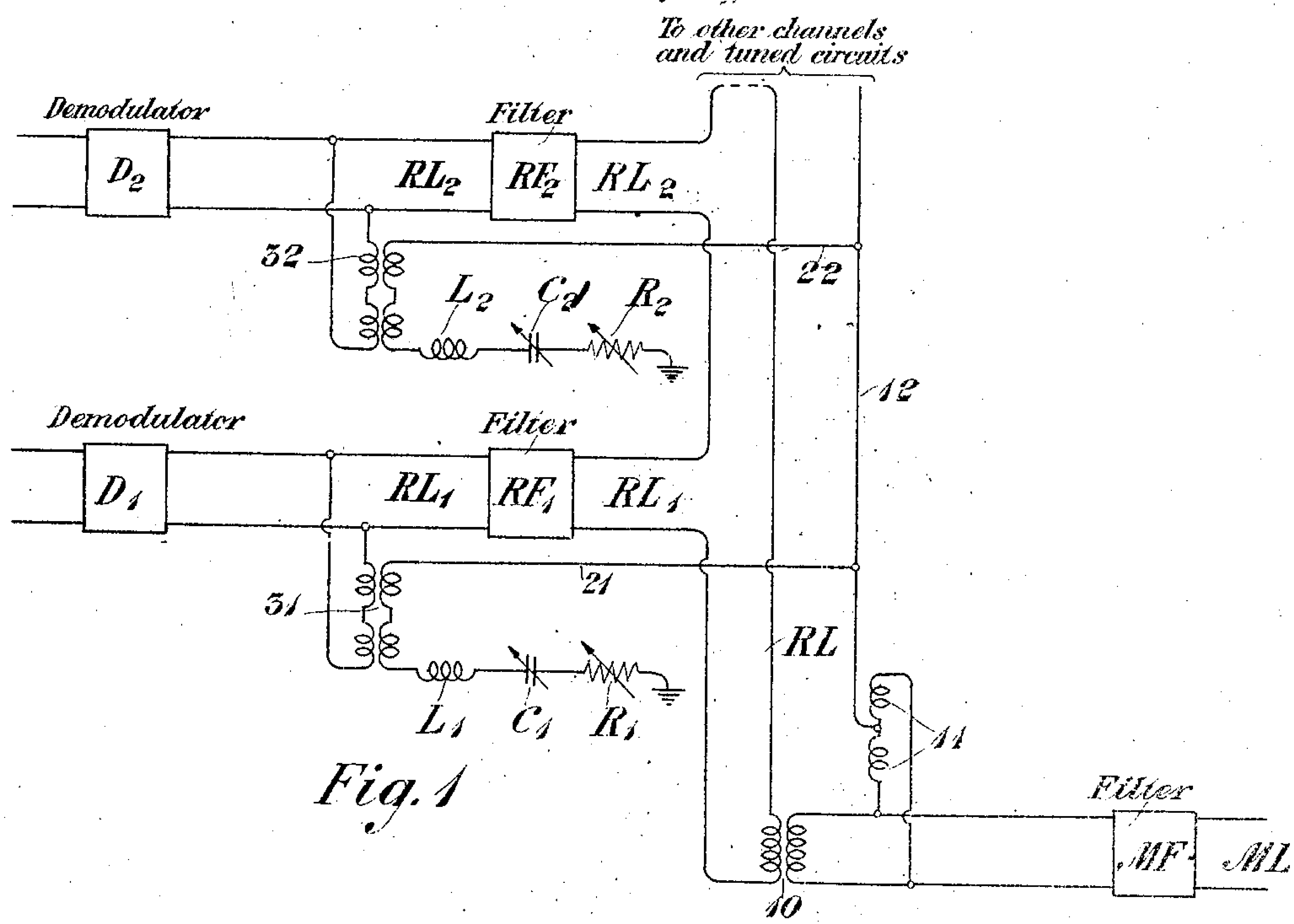

Fig. 1

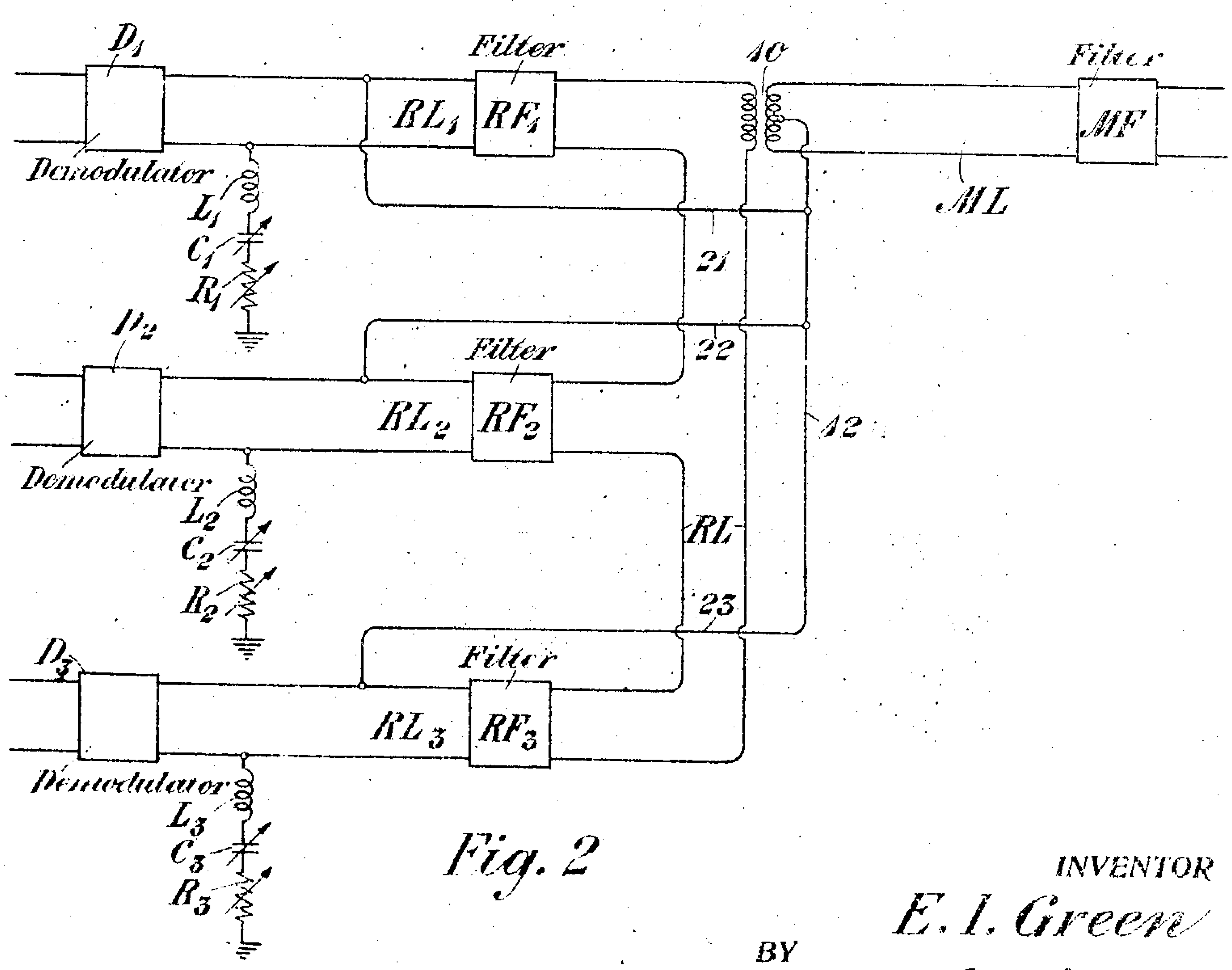

Fig. 2

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[illegible]

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ELIMINATION OF INTERFERENCE IN CARRIER SYSTEMS.

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To all whom it may concern:

Be it known that I, Estill I. Green, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain Improvements in Elimination of Interference in Carrier Systems, of which the following is a specification.

This invention relates to carrier systems and more particularly to the elimination of external interference in such system.

In systems employing carrier frequencies for the transmission of signals, one of the principal sources of external interference is due to radio transmitters employing frequencies lying within the range transmitted by a carrier channel. Such interference is produced by the line wires acting as an antenna to pick up the radiated wave and transmit it to the receiving carrier apparatus.

It has heretofore been proposed to overcome interference of this sort by picking up the interfering wave and impressing it upon the circuit at some point common to all of the carrier channels, with such phase and amplitude as to neutralize the interfering component transmitted over the line wires. While this method is quite satisfactory where only one interfering wave is involved, difficulty has been experienced where, as is usually the case, there are other interfering sources, and particularly where the circuit is subject to noise disturbances. In the case of a noise interference, such as that due to a power line, for example, the frequency and amplitude are quite variable and while the fundamental noise currents themselves are usually within the ordinary telephonic range, there are harmonics which fall within the carrier range.

These harmonics, when they appear in the circuits as interference, are usually of such small amplitude that they may be neglected. But where a selective circuit is provided for selecting and then changing the phase and amplitude relation of the wave from a definite interfering source, such as a radio station, the noise or other interfering currents will also be selected to some extent and will be transformed in amplitude and phase relation. If, then, these currents are impressed upon the carrier circuit at a point common to the channels, while the component corresponding to the radio wave will be of such amplitude and phase as to balance out the interference at that frequency, it by no means follows that the other interfering waves will neutralize the corresponding waves transmitted over the circuit, and in many instances, they will actually add to the noise or other interference components transmitted over the line, and thus increase the interference from these sources.

In accordance with the present invention it is proposed to overcome this difficulty by applying the component for neutralizing a particular interfering wave to the desired channel at a point beyond the band filter which is individual to that channel. As a consequence, any noise components introduced into the circuit will only affect that particular channel and cannot add to the noise components transmitted over the line and passing into other channels.

The invention may now be more fully understood from the following description when read in connection with the attached drawing, Figs. 1 and 2 of which illustrate two embodiments of the invention.

Referring to Fig. 1, ML designates the main transmission line of a carrier system, said line being connected through a transformer 10 to the common receiving circuit RL of carrier terminal apparatus. The receiving channels, such as RL_1 and RL_2, are connected to the common receiving channel RL and include band filters, such as RF_1 and RF_2 for selecting into each channel the proper band of frequencies. Demodulators such as D_1 and D_2, of any well-known type, are also included in the channels for translating the carrier frequencies into signaling currents.

Let us assume that two radio stations are transmitting, one within the range of the filter RF_1 and the other within the range of the filter RF_2, and that these radio stations are so located that undesirable interference results. The interfering waves from the radio station will flow over the two sides of the main line ML_1 in parallel, but due to the dissimilarity of the two sides of the line an unbalanced component will result, which tends to flow serially over the two sides of the line. The unbalanced component of the two radio waves will produce interference in the receiving channels RL_1 and RL_2 unless suitable measures are taken. By bridging an inductance element 11 across the conductors of the main line ML and taking a tap, such as 12, from the midpoint of the bridge 11, the wave component flowing over the two sides of the line in parallel (which does not cause any interference) may be received in a suitable circuit and so translated as to neutralize the interfering component, which tends to flow serially over the line.

One of the interfering components will, of course, flow into the channel RL_1 and in order to neutralize this component a branch 21, including the inductance L_1, capacity C_1 and resistance R_1, is connected to conductor 12. The inductance L_1 and capacity C_1 will be so adjusted that the circuit will be tuned to the frequency of the interfering wave. By means of the resistance R_1 the amplitude of the component received from the conductor 12 may be made equal in amplitude to the interfering component flowing into the channel RL_1. The capacity C_1 may then be adjusted to change the phase of the wave so that it will be impressed through the transformer 31 upon the receiving channel RL_1 in opposite phase relation to the interfering component transmitted through the filter RF_1. A change in phase may be made without materially changing the frequency at which the circuit is resonant, for the phase change is very large in response to a slight adjustment of the condenser at the resonance point.

Similarly, for the other interfering component entering the channel RL_2 a branch 22 may be taken from the conductor 12 and the inductance L_2, capacity C_2 and resistance R_2 may be adjusted to produce an electromotive force through the transformer 32, which opposes and neutralizes the interfering electromotive force passing through the filter RF_2.

It will be noted that the neutralizing electromotive forces are applied to the individual receiving channels at points beyond the band filters, such as R_1 and R_2, which select the desired bands into the channels. This is an important feature of the present invention for it overcomes, to a large extent, one of the difficulties encountered in interference arrangements heretofore employed. For example, let us consider the tuned circuit 21. Although this circuit is tuned to the frequency of the particular interfering wave with which we are concerned in the case of the channel RL_1, it cannot be made to absolutely discriminate against the frequency to which the circuit 22 is tuned. Consequently, a component of the other interfering frequency will also appear in the circuit 21. The adjustment of the capacity C_1 to produce the desired phase shift of the particular interfering component entering the channel RL_1 will also produce a phase shift in the component of the other interfering frequency which enters the branch 21. If, now, the branch 21 is connected to apply its energy to some part of the carrier circuit which is common to the channel such, for example, as the circuit RL or the transformer 10, as was the prior practice, not only will the particular component which it is desired to balance out be impressed upon the common circuit in opposite phase relation but the interfering component from the other station or stations will also be impressed upon the same circuit. The adjustment of the capacity C_1, which produces the right phase relation for the neutralizing component for the interfering frequency which enters the channel RL_1, will not produce the right phase relation for the other interfering frequencies, and it may very well happen that the energy of the other interfering frequencies impressed upon the common point of the circuit will be in such phase relation as to actually add to the other interfering frequency.

The same holds true for harmonics of noise waves upon the circuit. Owing to the irregular nature of the noise wave it is not readily possible to balance an interfering noise by producing another wave of opposite phase. Now, obviously, some of the harmonics due to noise waves will lie within the regions of both carrier channels and some of these noise components will enter both the circuits 21 and 22, notwithstanding the tuning of these circuits. These noise components, if impressed by circuits 21 and 22 upon the common part of the circuit such, for example, as the transformer 10, will not be in such phase relation as to neutralize the original noise components but will add to and increase the effect of the noise waves in the several channels.

On the other hand, by impressing the neutralizing electromotive force upon the individual channels beyond the band filters in accordance with the present invention it will be clear that any interfering components falling within the range of the band filter RF_2 and which are able to enter the branch tuned circuit 21 cannot be cumulatively effective with the original noise components in the channel RL_2, for the balancing components will be applied to the channel RL_1 beyond the filter RF_1 and cannot pass back through the filter into the channel RL_2 as they will be suppressed by the filter RF_1.

A modified arrangement is illustrated in Fig. 2. In this figure, the balancing components are obtained by connecting the tap 12 to the midpoint of the primary of the transformer 10, which couples the main line ML to the various carrier channels. Also, instead of coupling the tuned branches 21, 22 and 23 to the receiving channels through transformers, as in Fig. 1, the tuned branches are directly connected to the receiving channels RL_1, RL_2 and RL_3 beyond the band filters, the conductors 21 being connected to one wire of each channel and the other wire of each channel being connected to ground through the inductances, capacities and resistances, such as L_1, C_1 and R_1. The principle of the arrangement shown in Fig. 2, however, is the same as that of Fig. 1, and no further description is deemed necessary.

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 carrier system comprising a main line and a plurality of branch receiving channels, each having a filter therein for selecting a desired range of frequencies for each channel, an arrangement for neutralizing an interfering component comprising means for receiving energy corresponding to the interfering component, means for producing from said energy a wave equal in amplitude but opposite in phase to the interfering component, and means for impressing the wave thus translated upon the channel interfered with at a point beyond the filter in that channel whereby the balancing wave will be prevented from reacting in other channels.

2. In a carrier system comprising a main line and a plurality of branch receiving channels, each having a filter therein for selecting a desired range of frequencies for each channel, an arrangement for neutralizing interfering components comprising means for receiving energy corresponding to the interfering components, means for separating the components falling into the range of each receiving channel, and means for impressing upon each channel the separated components corresponding to the range of that particular channel at a point beyond the filter in such phase relation as to neutralize the interfering wave transmitted by that channel through the filter.

3. In a carrier system comprising a main line and a plurality of branch receiving channels, each having a filter therein for selecting a desired range of frequencies for each channel, an arrangement for neutralizing interfering components comprising means for receiving energy corresponding to the interfering components, means for separating the components falling into the range of each receiving channel, means for impressing upon a given channel the separated components corresponding to that channel, and means for adjusting the phase and amplitude of the energy thus impressed so that it will be equal in amplitude and opposite in phase to the interfering components entering the channel.

4. In a carrier system comprising a main line and a plurality of branch receiving channels, each having a filter therein for selecting a desired range of frequencies for each channel, arrangements for neutralizing the effect of interfering wave components flowing serially with respect to the line wires of the system, said arrangements comprising a bridge connection for the line, a conductor connected to a midpoint of the bridge to take off components of the interfering wave flowing over the two sides of the line in parallel, branches for said conductor, each tuned to a different interfering frequency, and connections from each of said branches to the channel within whose range the frequency of the branch lies, said connections being made at the points beyond the filter in the channel.

5. In a carrier system comprising a main line and a plurality of branch receiving channels, each having a filter therein for selecting a desired range of frequencies for each channel, arrangements for neutralizing the effect of interfering wave components flowing serially with respect to the line wires of the system, said arrangements comprising a bridge connection for the line, a conductor connected to a midpoint of the bridge to take off components of the interfering wave flowing over the two sides of the line in parallel, branches for said conductor, each tuned to a different interfering frequency, connections from each of said branches to the channel within whose range the frequency of the branch lies, said connections being made at points beyond the filters in the channels, and means for adjusting the phase and amplitude of the currents flowing in the branches so that they will be impressed upon corresponding channels with equal amplitude and in opposite phase relation to the interfering components passing into the channels through the filters.

In testimony whereof, I have signed my name to this specification this 17th day of April 1924.

ESTILL I. GREEN.