

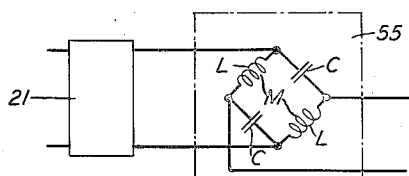
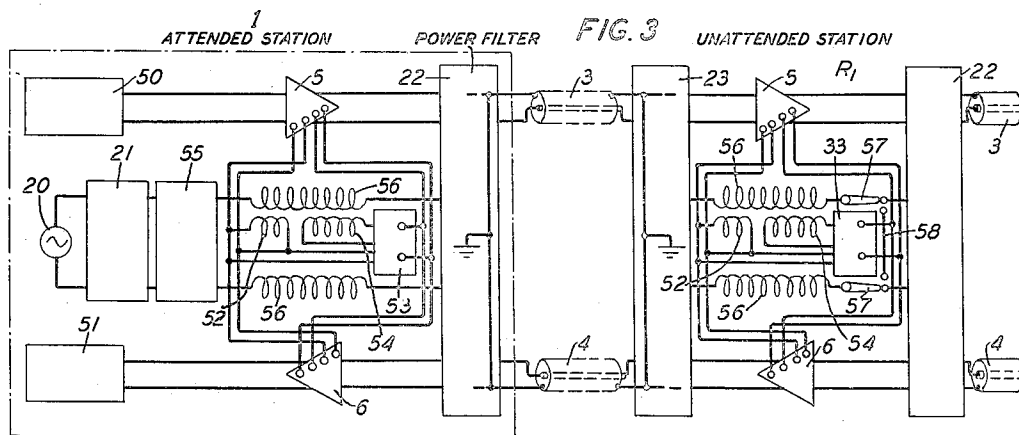
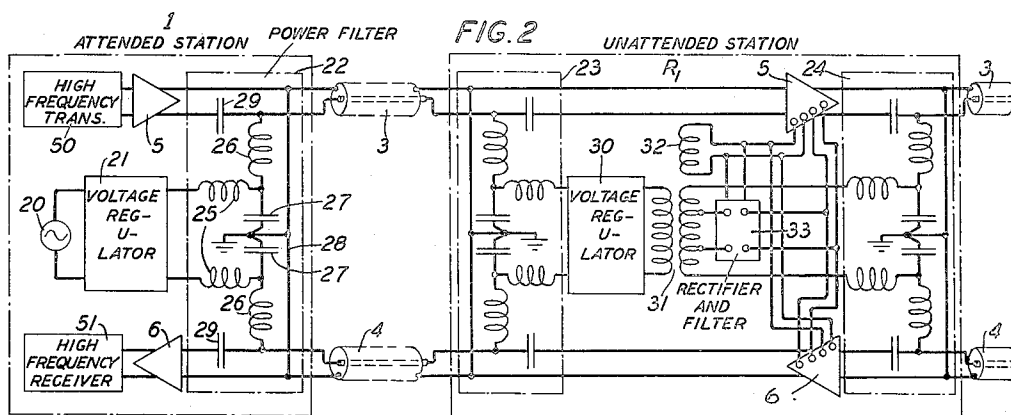
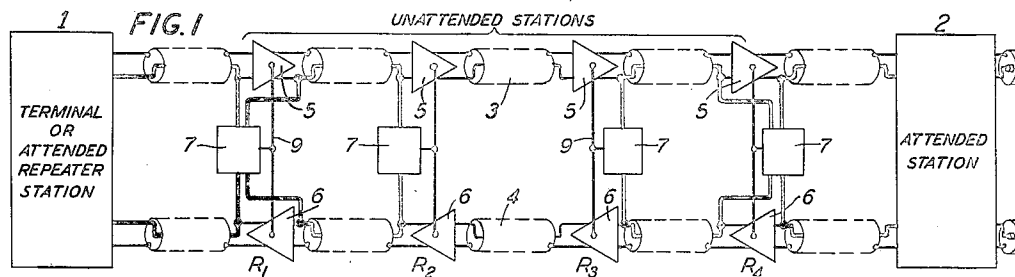
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CARRIER LINE POWER SUPPLY

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## CARRIER LINE POWER SUPPLY

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5 Claims. (Cl. 178-44)

The present invention relates to carrier wave signaling employing coaxial conductor lines, and more particularly to the supply of power over such lines to outlying unattended repeater stations.

A practical type of coaxial conductor system is one using two separate coaxial pairs, one for transmitting exclusively in one direction and the other in the other direction. One-way repeaters are inserted in each line at intervals of the order of five or ten miles. It is uneconomical of plant, space and personnel to make each of these repeaters an attended station requiring suitable location and housing. The attended stations may, for example, be at intervals of fifty miles, with four unattended stations between each two attended stations.

In supplying power from the attended stations out over the lines to the unattended stations to energize the repeaters along the lines, the problem arises of getting sufficient power to the points where it is needed with safety to equipment and personnel and of keeping the amount of power supplied at a proper value under the varying conditions of service.

Four-wire coaxial conductor systems will generally be fairly long and involve a large number of repeaters in tandem from end to end. In such a system it is extremely important to keep the power supplied to the repeaters at a proper value since the repeater gain is inevitably affected by changes in power supply. With a large number of tandem repeaters a change in gain that might be insignificant from the standpoint of the individual repeater may amount in the aggregate to a serious disturbance to the proper operation of the system for transmitting signals.

A general object of the invention is to supply power over a pair of coaxial lines to repeaters located on the lines.

Further objects are to supply adequate power without use of excessive voltage on any part of the system and to maintain the power so supplied at proper value under all operating conditions.

A better understanding of the invention and its various features and objects will be had from the following detailed description in connection with the accompanying drawing, in which:

Fig. 1 is a block diagram showing the general layout of a pair of attended stations with intermediate unattended repeaters;

Fig. 2 is a schematic circuit diagram of a terminal and one unattended repeater showing one manner of supplying power over the coaxial lines;

Fig. 3 is a similar circuit diagram showing an alternative manner of supplying power over the coaxial lines; and

Fig. 4 is a detail showing of a constant current device that may be used in the circuit of Fig. 3.

In Fig. 1 two attended stations 1 and 2 are shown interconnected by a pair of coaxial conductor lines 3 and 4. The attended station 1 may be either a terminal station or an attended repeater station and it is assumed that station 2 is a repeater station. Intermediate to the stations 1 and 2 are shown a number of unattended repeater stations R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, and R<sub>4</sub>. Each of these latter stations includes an eastward one-way repeater 5 and a westward one-way repeater 6.

It is assumed that a source of power is located at each of the attended stations. This power may, for example, be derived from a commercial 60-cycle system. Power from such a source is supplied from station 1 to repeater stations R<sub>1</sub> and R<sub>2</sub> over a two-wire circuit comprising the central conductors of the coaxial lines 3 and 4, the general power circuit or the route traversed by the power currents being indicated in this figure in heavy lines. Similarly, power is supplied from station 2 over the central conductors of the two coaxial lines to the repeater stations R<sub>3</sub> and R<sub>4</sub>. At each of the unattended stations a circuit 7 is provided for two purposes, (1) for taking off some of the power supplied over the central conductors and applying this power in proper form to the repeaters 5 and 6 for energizing the tubes in these repeaters, and (2) for transmitting some of the power on to the next unattended repeater if that is desired. The circuit 7, for example, may include suitable transformers, rectifiers, etc. to be described more fully hereinafter. Leads 9, which may in practice be a group of conductors, extend from the circuit 7 to each of the amplifiers in the repeaters 5 and 6.

In similar fashion power would be supplied from the attended station 2 over the coaxial conductors extending to the right in Fig. 1 to one or more unattended stations in each direction.

Reference will now be made to Fig. 2 which shows in greater detail the circuits at the attended station 1 and at the first unattended repeater station R<sub>1</sub>. The station 1 is shown as comprising suitable high frequency transmitting apparatus 50 and high frequency receiving apparatus 51 preferably in the form of multiplex terminal circuits for respectively impressing on the outgoing conductor 3 and receiving from the incoming conductor 4 modulated carrier waves in

a large number of channels extending over a frequency range of the order of hundreds or thousands of kilocycles. Terminal amplifiers 5 and 6 are shown associated with the transmitting and receiving circuits, these amplifiers being energized in any suitable manner not specifically indicated in this drawing. These terminal multiplex transmitting and receiving circuits may, for example, be of the type disclosed in United States patent to Espenschied et al. 1,835,031, December 8, 1931, or of any other suitable type.

The station 1 comprises also a source of alternating current power such as the usual 60-cycle commercial system, the source being indicated at 20. The terminals of this source 20 are connected through a voltage regulator 21 and through a power filter 22 to the central conductors of the two coaxial conductor lines 3 and 4. The voltage regulator 21 is for the purpose of holding the voltage impressed on the line constant and may be of any suitable or well-known type. The power filter 22 is for the purpose of allowing the power current as well as the high frequency signaling current utilized by the terminal apparatus 50 and 51 to traverse the lines 3 and 4 without mutual interference in the terminal apparatus. This filter may comprise series condensers 29, which are of a size to offer low impedance to the high frequency signaling current but very high impedance to the power current; inductances 25 and condensers 27 and also inductances 26. The inductances 25 and 26 offer very high impedance to currents of the signaling frequency, but low impedance to the power current. Condensers 27 are of high impedance at the power frequency, but low impedance at the signaling frequency. By means of this filter the high frequency signaling currents are prevented from entering the power circuit and the power currents are prevented from traversing the terminal circuits used by the signaling currents. The outer shells of the coaxial lines 3 and 4 are connected to ground at 28, which is also preferably the mid-point of the power supply voltage.

At the repeater station R<sub>1</sub> a power filter 23, which may be entirely similar to power filter 22, is used to enable the high frequency signaling current and the low frequency power current to be separated to their respective circuits without mutual interference. The high frequency signaling currents on the line 3 pass into the amplifying repeater 5 and after amplification they pass through the power filter 24, which may be similar to power filter 23, and out on the outgoing section of coaxial line 3. The high frequency signaling currents in the opposite direction are amplified at 6.

The power currents traverse the voltage regulator 30, the output of which is connected to transformer 31. Transformer 31 has a small secondary winding 32 for supplying the heaters or filamentary cathodes, as the case may be, of the tubes used in the amplifiers 5 and 6. Voltage taps on the secondary of the transformer 31 supply energy to the circuit 33 which may comprise the usual rectifier and filter for developing direct current voltages of the proper magnitude to supply the plate and screen grid circuits of the amplifiers 5 and 6. Leads are shown from the rectifier filter circuit 33 to the respective amplifiers 5 and 6. The secondary of the transformer 31 also leads through the output power filter 24 to the section of lines 3 and 4 leading to the next repeater station R<sub>2</sub>.

At the next repeater point (not shown) on the

lines 3 and 4 an entirely similar arrangement of apparatus may be provided except that if the power currents are not to be relayed further than such repeater (see Fig. 1) the secondary of the transformer 31 at that repeater leads only to the rectifier filter circuit 33 of that station and not to a power filter corresponding to filter 24.

It will be observed in Fig. 2 that the current may be transmitted over the lines 3 and 4 at a terminal voltage twice as high as that appearing between the conductors of either coaxial conductor. Thus, if the terminal voltage of the power circuit attached to the central conductors of the two coaxial lines is 500 volts, the voltage between the conductors of either line is 250 volts. Moreover, the outer conductor is grounded and the high potential conductor is the central conductor which is spaced a substantial distance away from the outer conductor by means of high grade insulators. A lineman or other person approaching the coaxial conductors does not come into contact with the high potential conductor. The provision of the voltage regulator 30 at each of the unattended repeater stations maintains the voltage applied to the repeaters at a constant value notwithstanding that there may be fluctuations in voltage received over the lines 3 and 4 due to such variable factors as temperature or line losses.

The circuit of Fig. 3 differs from that of Fig. 2 in being a constant current rather than a constant voltage system. At the station 1 the same high frequency transmitter circuit indicated at 50 and high frequency receiving circuit indicated at 51 are assumed as in the case of Fig. 2. Also, a source 20 of suitable low frequency alternating current and a voltage regulator 21 are shown for maintaining the voltage constant at the output terminals of the device 21. A constant current device 55 is connected to the output terminals of the device 21 and the output terminals of the constant current regulator 55 are connected through primary winding 56 to the power filter 22 which may be identical with that shown in Fig. 2.

Two secondary windings are shown for the primary windings 56 comprising a low voltage filament or heater winding 52 and a high voltage winding 54 leading to rectifier filter combination 53 used to supply to the amplifiers 5 and 6 a direct current voltage or series of voltages for fixing the potentials of the plate and screen electrodes of the tubes.

At the repeater station R<sub>1</sub> the high frequency signaling waves pass directly through the amplifier 5 or 6 to the outgoing sections of their respective lines. The power currents are taken off from the output terminals of filter 23 (as in the case of Fig. 2) and supplied through a suitable transformer 56 to the output power filter 24 leading to the next line section. The transformer 56 is shown connected in series with the line in this case. Rectifier-filter combination 33 derives suitable voltage from winding 56 and applies such voltage, rectified and filtered, to the tubes in the repeaters 5 and 6. Filament or cathode heating current is derived from one of the secondary windings of transformer 56.

At the last unattended repeater station to which power is to be supplied over a given circuit, no outgoing circuit from that station for the power currents will be necessary. It is sufficient simply to connect the extreme ends of the power circuits together as is indicated in Fig. 3 by considering that switches 57 are thrown to their alternate positions and includes, therefore,

the short piece of conductor 58 directly across the line.

5 A constant current device suitable for use at 55 in Fig. 3 is shown in detail in Fig. 4. To the terminals of the constant voltage device 21 there is connected a circuit of bridge configuration comprising condensers C and inductances L mutually related to each other, the total inductance resonating with the total capacity at the power frequency. The load is connected across a diagonal of this circuit as illustrated. The action of such a circuit in maintaining the current constant under varying load conditions is explained by Steinmetz in "Alternating Current Phenomena" (1916) pp. 76, 77. Any other suitable regulator, such as a transformer with counter-weighted movable secondary coil, may be used.

10 With the constant current method of distribution shown in Fig. 3 the only regulation necessary is the constant current device at the attended station where the power is supplied to the line, no regulating apparatus corresponding to the voltage regulator of Fig. 2 being necessary at the unattended station.

25 The amplifying repeaters used at 5 and 6 are preferably of the general type of repeater disclosed in application for United States Letters Patent of H. S. Black, Serial No. 606,871 filed April 22, 1932.

30 It will be understood that the invention is capable of variations and modifications to meet the varying requirements of practical application without departing from the spirit of the invention as defined in the following claims.

35 What is claimed is:

1. In a high frequency carrier wave transmission system, two coaxial conductor lines connecting a pair of terminal or attended stations, means to transmit high frequency carrier waves between said stations over one of said lines in one direction and over the other of said lines in the opposite direction, one-way repeaters in tandem in each line between said stations, a power transmission circuit comprising portions of the cen-

tral conductors of each of said coaxial lines in a series circuit extending from a terminal or attended station through at least one repeater point, means at said terminal station to supply power currents to said power transmission circuit, and a local circuit at a repeater point for deriving power from the circuit comprising said central conductors and using the derived power to energize the repeaters, at that point, in the two coaxial lines.

2. A system according to claim 1 in which said power transmission circuit comprises a voltage regulator at the attended station and at each repeater point for supplying power of constant voltage to the respective repeaters and to each section of the power circuit.

3. A system according to claim 1 in which said power transmission circuit includes a suitable source of power at the terminal or attended station, together with means for maintaining constant the current applied from said source to the conductors of the power circuit, whereby a constant current is delivered to the repeater points notwithstanding changes in resistance of the conductors of the power circuit.

4. In a carrier wave system, two coaxial conductor lines extending between geographically separated stations, repeaters at intervals on each line between said stations, means to transmit carrier waves over each line between said separated stations, means to amplify the waves at said repeater points, and a power circuit extending from one of said stations to a plurality of said repeaters for supplying alternating energizing current to said repeaters, said power circuit comprising the central conductor of one coaxial line as one side and the central conductor of the other coaxial line as the return side.

5. A system according to claim 4 in which means is provided to maintain constant the alternating current sent over said power circuit under the varying conditions of service.

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