Oct. 16, 1928. 1,688,036

L. M. CLEMENT

RADIANT ENERGY TRANSMISSION SYSTEM

Filed Aug. 5, 1924

Fig.1

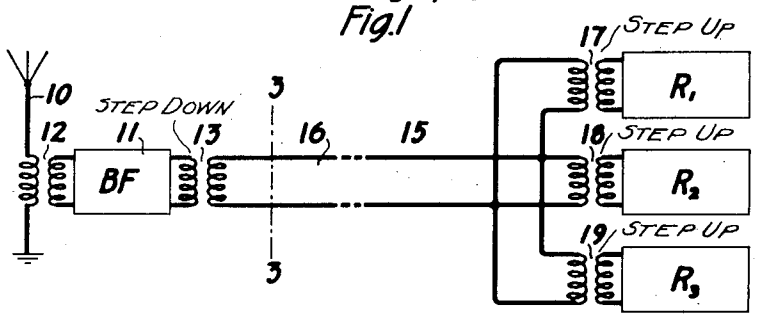


Fig.2

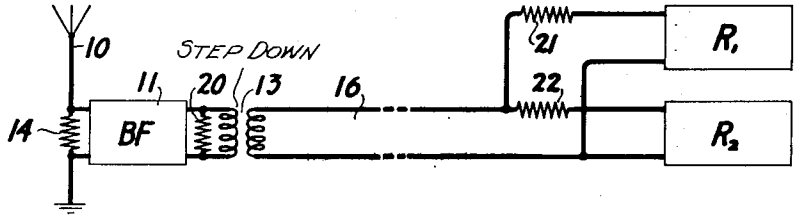


Fig.3

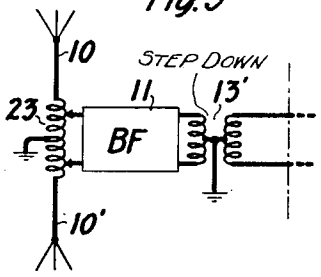


Fig.4

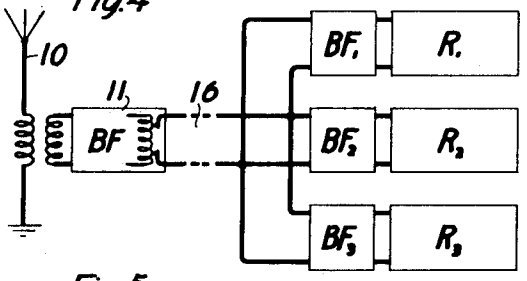
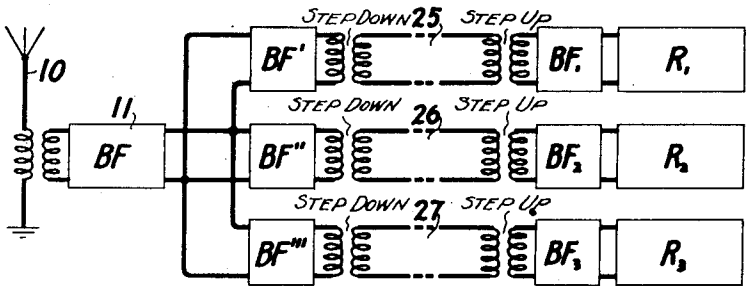


Fig.5



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UNITED STATES PATENT OFFICE.

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RADIANT-ENERGY-TRANSMISSION SYSTEM.

Application filed August 5, 1924. Serial No. 730,159.

This invention relates to radiant energy transmission systems and more particularly to systems having improved means for coupling an antenna to receiving devices.

In adapting radio receiving systems to certain uses, a solution of the problem of distributing signal waves received by a common receiving conductor to receiving devices located at a distance therefrom becomes necessary. This problem presents itself, for example, in connection with the installation of radio receiving systems in apartment houses and on battleships. In these instances, it becomes desirable to be able to transmit waves received by a common receiving antenna to a plurality of radio receiving stations located in different apartments in the one case or at a central point in the battleship in the other case. The present invention affords a solution of the problem by the provision of means for coupling an antenna to receiving stations at a distance therefrom which efficiently transmits high frequency waves.

An object of this invention is to transmit high frequency waves without substantial attenuation.

Another object is to couple an antenna to receiving devices by means having low impedance.

An additional object is to distribute high frequency waves to a plurality of receiving stations without substantial attenuation.

Another object is to transform the voltage of high frequency waves to allow their transmission without substantial loss of power.

A feature of the invention relates to means for coupling an antenna to radio receiving devices that have low impedance to high frequency waves.

This invention provides means for the transmission of high frequency waves, for example, between an antenna and receiving sets. It includes means for transforming the voltage of high frequency waves at each end of a conducting line. To reduce the leakage effect of line capacity in producing attenuation of high frequency waves, the voltage of waves supplied to the input end of the line is stepped down to a low value. The wave energy is thus transmitted over the line at low voltage and, at the output end of the line, the voltage of the transmitted energy may be stepped up before it is supplied to the receiving devices. As a consequence, the attenuation of the high frequency waves is greatly reduced.

This invention is particularly applicable to radio receiving systems wherein it may be desirable to transmit received radio frequency waves from an antenna to one or more receiving devices at a distance therefrom. In some instances, a plurality of high frequency waves, representing carrier waves in different signaling channels may be transmitted via a single coupling line, such as has been described above, to a plurality of selective receiving devices. In other instances, individual coupling lines may be provided for separately transmitting the carrier waves of different signaling channels. Desired waves may be selected and undesired waves excluded from the receiving devices in any case by the use of properly designed filters, placed either at the antenna or at the receiving stations or at both points. The voltage of the transmitted waves may be transformed by means of transformers, amplifiers or like devices.

In the drawings—

Fig. 1 is a circuit diagram of a radio receiving system in which an antenna 10 is coupled to a plurality of radio receiving sets R_1, R_2, and R_3 by a high frequency coupling line 16.

Fig. 2 is a circuit diagram in which resistance coupling to the antenna and receiving devices is employed.

Fig. 3 is a circuit diagram illustrating a balanced coupling to an antenna and counterpoise.

Fig. 4 is a circuit diagram of a multiplex radio receiving system provided with filters both at the antenna and at the receiving devices.

Fig. 5 is a circuit diagram of a multiplex receiving system having an individual coupling line for each receiving device.

The radio receiving system, the circuit diagram of which is shown in Fig. 1, comprises antenna 10, which may be an open type, loop type, or other form of antenna, a wave selecting device or filter 11, a high frequency

coupling system 15 and individual receiving sets, R_1, R_2 and R_3. The antenna 10 is connected to ground in series with the primary winding of transformer 12. The secondary winding of transformer 12 is connected to the input terminals of band filter 11. The output end of this band filter is coupled to the low impedance line 16 by step-down radio frequency transformer 13. At its output end, the line 16 is coupled to radio receivers R_1, R_2 and R_3 by step-up transformers 17, 18 and 19 in multiple. The transformer 13, the line 16 and the transformers 17, 18 and 19 constitute the coupling system 15. Radio receivers R_1, R_2 and R_3 are connected respectively to the secondary windings of transformers 17, 18 and 19.

The radio frequency band filter 11 is designed to transmit, without substantial attenuation, waves of frequencies which it is desired to receive and to greatly attenuate waves of undesired frequencies. The step-down transformer 13 is designed to transmit high frequency waves and to reduce the voltage of those waves applied to the coupling line 16. Conversely, the transformers 17, 18 and 19 are designed to transmit radio frequency waves and to step-up the voltage of those waves. The transformers 17, 18 and 19 may be replaced by space discharge tube amplifiers or other devices for transforming the voltage of received waves. The secondary winding of transformer 13, the line 16, and the primary windings of transformers 17, 18 and 19 preferably have low impedance.

In the operation of the system of Fig. 1, high frequency waves, corresponding to signals, are received by antenna 10 and transmitted through transformer 12 to band filter 11. Filter 11 selectively transmits desired waves and attenuates undesired waves. The voltage of high frequency waves received by antenna 10 is stepped down by means of transformer 13. The high frequency waves are thus transmitted over line 16 at low voltage. These waves are stepped up in voltage at transformers 17, 18 and 19, and then applied to the respective radio receivers, R_1, R_2 and R_3.

For high frequency waves, the capacity component of the impedance of transmission line 16 predominates over other components of this impedance for any appreciable length of the line. By reducing the voltage of the high frequency waves applied to the transmission line 16, the effect of the capacity component impedance of the line in producing attenuation of these waves is materially reduced. The current transmitted is proportional to the applied voltage but the loss in energy caused by attenuation is proportional to the square of the voltage. It therefore results that by reducing the voltage of the waves to be transmitted by one-half, for example, the loss of energy caused by attenuation may be reduced to one-fourth of its former value.

In Fig. 2, a circuit diagram of a radio receiving system is illustrated. In this figure, the antenna 10 is connected to ground in series with the resistance 14. The radio frequency band filter 11 has its input terminals connected to the terminals of resistance 14. The output terminals of band filter 11 are connected to resistance 20 which is connected in shunt to primary winding of transformer 13. The resistances 14 and 20 serve to prevent reaction between the filter 11 and the antenna 10 and the line 16. These resistances are preferably designed to match the filter input and output impedances respectively. The secondary winding of transformer 13 is connected to the low impedance line 16. The output terminals of line 16 are connected to the radio receivers R_1, and R_2.

The respective branches of line 16, connected to receivers R_1 and R_2, contain resistances 21 and 22. These resistances are provided to prevent mutual reaction between the receivers R_1 and R_2. They, in effect, loosen the coupling between the receivers and allow either to be tuned without effect upon the tuning of the other.

In Fig. 3, a modification of the antenna 10 of the radio receiving system illustrated in Fig. 1 is shown. This modification, which may be substituted for the portion of Fig. 1 to the left of line 3—3, includes antenna 10 connected to one terminal of inductance 23 and counterpoise 10′ connected to the opposite terminal of this inductance. The mid-point of inductance 23 is connected to ground. The input terminals of band filter 11 are connected to adjustable contacts on inductance 23. The inductance 23 is preferably adjusted to match the impedance of the filter 11. A transformer 13′, the primary winding of which is connected to the output terminals of band filter 11, has a ground connection at the mid-point of its primary and secondary windings. This modification provides a balanced circuit for use when a counterpoise is employed. This arrangement enables the effective potential of the counterpoise 10′ with respect to ground to be maintained the same as the effective potential of the antenna to ground.

In the system illustrated in Fig. 4, band filters are provided both at the antenna end and at the receiver end of the low impedance transmission line 16. Three receiving channels associated respectively with radio receivers R_1, R_2, and R_3, each include a band filter BF_1, BF_2, and BF_3, respectively. In this figure, the step-down and step-up transformers are omitted and instead the filters 11, BF_1, BF_2 and BF_3 are designed to perform the necessary voltage transformation.

The system shown in Fig. 4 is particularly

suitable for multiplex radio reception. The band filter 11 is designed to transmit waves within the band of frequencies including the carrier waves corresponding to the receiving channels 1, 2 and 3. The band filters BF_1, BF_2, and BF_3 are each designed to selectively transmit the carrier wave corresponding to the associated channel.

The band filters BF_1, BF_2, and BF_3, being located at the receiving sets, have the additional function of discriminating between desired waves and extraneous waves picked up by transmission line 16.

The circuit diagram of Fig. 5 is that of a multiplex radio receiving system wherein individual coupling lines are provided for separate receiving channels. The output terminals of band filter 11 are connected in multiple to the input terminals of individual channel band filters BF′, BF″ and BF‴. The output terminals of the latter filters are connected to the coupling systems 25, 26 and 27, respectively. Additional band filters BF_1, BF_2, and BF_3 are provided at the receiver ends of the coupling systems for discriminating between desired waves and extraneous energy picked up by the coupling lines. These filters also supplement the band filters BF′, BF″ and BF‴ in selecting the carrier wave corresponding to the associated channel and attenuating waves corresponding to other channels. The system shown in this figure combines high efficiency in the transmission of radio frequencies with high selectivity in the discrimination between desired and undesired waves. This modification is especially suited for use where the radio receivers R_1, R_2 and R_3 are located at widely separated points.

For the purposes of explanation, this invention has been illustrated and described in connection with certain specific embodiments, but it is to be limited only by the scope of the appended claims.

What is claimed is:

1. An electric wave transmission system comprising an antenna, a radio apparatus at a distance from said antenna, a line having normally high attenuation connected between said antenna and said radio apparatus and means including a step-down transformer connected to said line for enabling the transmission of high frequency waves without substantial attenuation.

2. A radio receiving system comprising an antenna, a radio receiver, and means for coupling said receiver to said antenna comprising a two winding step-down transformer, a two winding step-up transformer and a line connecting the secondary of said step-down transformer to the primary of said step-up transformer, said means being designed to efficiently transmit high frequency waves.

3. A radio receiving system which comprises an antenna, a plurality of radio receivers, and means for coupling said receivers to said antenna comprising a two winding step-down transformer, a plurality of two winding step-up transformers and a line connecting the secondary of said step-down transformer to the primaries of said step-up transformers, said means being designed to efficiently transmit high frequency waves.

4. A radio receiving system which comprises an antenna, a plurality of sets of signal receiving apparatus, and means for selectively transmitting high frequency waves between said antenna and said sets of apparatus without substantial attenuation which comprises a filter, and a low impedance line and a step-down transformer coupling said filter to said line.

5. A radio receiving system which comprises an antenna, a plurality of sets of radio receiving apparatus, a single low impedance coupling line for said antenna and receiving apparatus designed to reduce the attenuation of high frequency waves transmitted thereover, and means for preventing mutual reaction of each of said sets upon the others.

6. In a radio receiving system an antenna, a counterpoise, a common ground connection for said antenna and counterpoise, a band filter, means for coupling said filter to said antenna and counterpoise in a balanced arrangement, said means having an impedance which is adjustable to match the input impedance of said filter, a low impedance coupling system and a plurality of radio receiving devices, said coupling system being arranged in energy transfer relation between said filter and said devices.

7. In a radio receiving system an antenna, a plurality of radio receivers, and individual low impedance coupling lines between said antenna and said receivers comprising step down transformers for transforming the voltage of waves transmitted over said lines to a low value.

In witness whereof, I hereunto subscribe my name this 28th day of July A. D., 1924.

LEWIS M. CLEMENT.