Aug. 28, 1923. 1,465,932

E. H. COLPITTS

MULTIPLEX RADIO TELEGRAPH SYSTEM

Original Filed Sept. 11, 1915

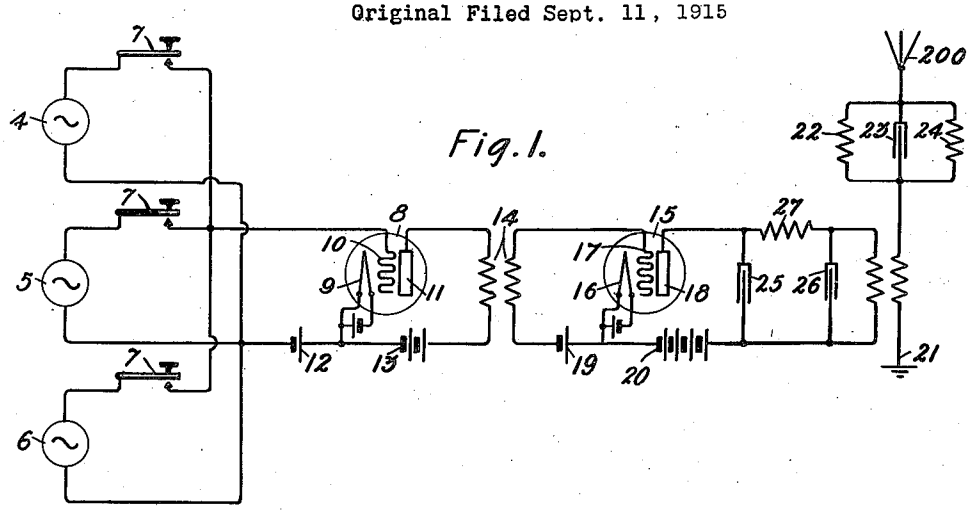


Fig. 1.

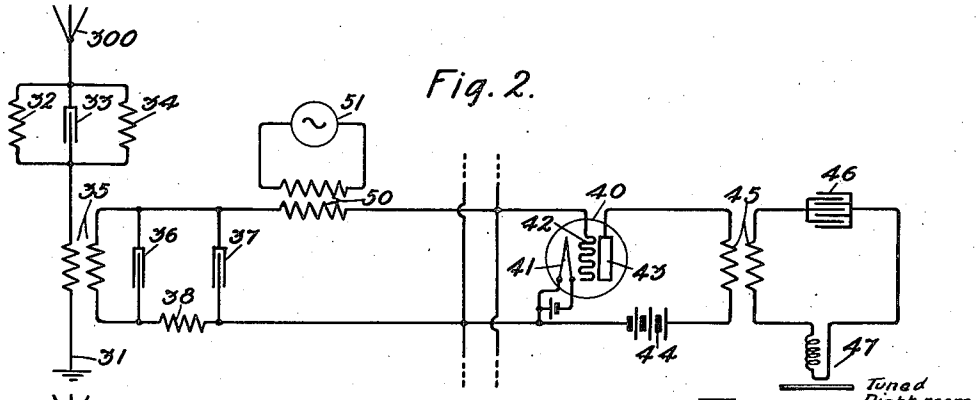


Fig. 2.

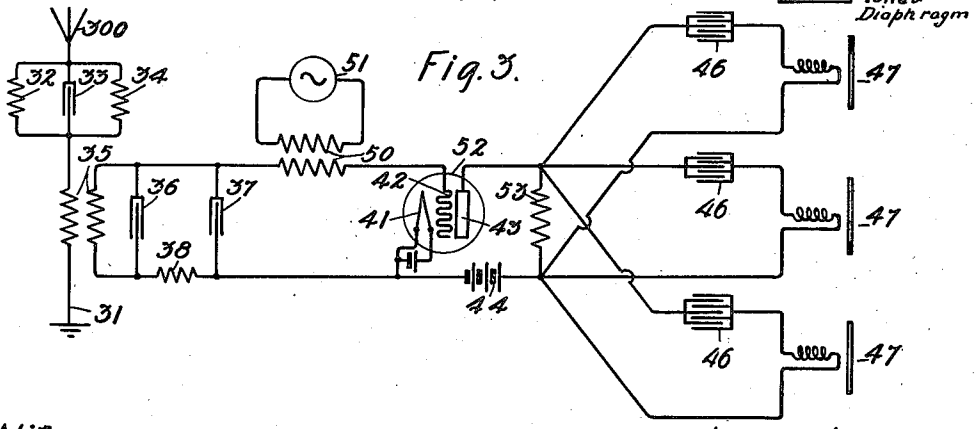


Fig. 3.

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by J. L. Roberts Atty

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UNITED STATES PATENT OFFICE.

EDWIN H. COLPITTS, OF EAST ORANGE, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WESTERN ELECTRIC COMPANY, INCORPORATED, A CORPORATION OF NEW YORK.

MULTIPLEX RADIOTELEGRAPH SYSTEM.

Application filed September 11, 1915, Serial No. 50,172. Renewed November 2, 1920. Serial No. 421,764.

To all whom it may concern:

Be it known that I, EDWIN HENRY COLPITTS, a subject of the King of Great Britain, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Multiplex Radiotelegraph Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to the transmission and reception of signals, and more particularly to multiplex telegraphy whereby a plurality of messages are transmitted simultaneously from one or several stations and may be received simultaneously on one antenna or on a plurality of antennæ located at the same place or at various places.

One of the objects of the invention is to overcome the difficulties encountered in making and breaking, for signaling purposes, circuits carrying large power. A further object is to avoid, in multiplex radio signaling systems, the duplication of apparatus of large size for the production of power of different frequencies. These objects are obtained by using a plurality of generators of high frequency oscillations of low power, controlling the power from these generators in accordance with signals to be transmitted and then amplifying this controlled and modulated power.

A further object is to receive the plurality of signals separately and without confusion, and to this end use is made of a source of high frequency oscillations at the receiving station, which oscillations combine with the received oscillations to give a beat frequency of a definite period. Oscillations of this beat frequency can then be received with high selectivity by apparatus both electrically and mechanically tuned to this beat frequency.

Referring to the drawings: Fig. 1 shows a transmitting station; Fig. 2 shows a receiving station to be used in conjunction with such a station as is shown in Fig. 1; Fig. 3 shows a modification of the circuit shown in Fig. 2. In these figures, 4, 5 and 6 represent generators of high frequency low power oscillations. These generators may be of any suitable type, such as dynamos, mercury vapor oscillation generators or thermionic oscillation generators of the audion type. Each of these generators is supplied with a signaling key 7 and all are connected in parallel to the input circuit of a thermionic amplifier 8. This amplifier has the usual input electrodes, 9 and 10, consisting of a heated element and a grid, and the usual output electrodes 9 and 11, 11 representing the usual plate electrode. A battery 12 is placed in the input circuit as shown to determine the potential of the grid 10, and a battery 13 is placed in the output circuit for supplying the power necessary for said output circuit. The output circuit of this amplifier is connected by means of the transformer 14 to the input circuit of a power amplifier 15. This power amplifier, which in general will consist of a plurality of tubes connected in parallel, is here shown diagrammatically and possesses the usual heated element 16, grid 17 and plate 18. The input circuit includes the battery 19, and the output circuit includes the battery 20. The manner of connection and operation of this power amplifier is fully set forth in patents to Arnold 1,129,942 and 1,129,943.

To the output circuit of this power amplifier is inductively connected the radiating antenna system comprising the elevated conductor 200, which is connected to ground at 21.

In order to improve the efficiency of radiation, it has been found desirable to give this radiating antenna a number of degrees of freedom agreeing with the number of messages to be transmitted. The increase in the number of degrees of freedom is obtained by making this antenna system more complex, and one method for doing this is shown in Figure 1, in which 22, 23 and 24 show reactances connected in parallel to each other and in series to the elevated conductor 200. In view of these degrees of freedom imparted to the radiating system it is possible to tune the antenna to each and all of the frequencies to be used for signaling. In this case it is also desirable to give the output circuit of the power amplifier an equal number of degrees of freedom, one method for accomplishing which is shown by inserting the condensers 25, 26 and the inductance 27, in the manner shown.

At the receiving station a similar antenna system is used consisting of the elevated conductor 30, earth connection 31 and reactances 32, 33, 34. Inductively connected to this antenna system by means of the transformer 35 is a circuit tuned to the frequencies of the signals to be received, the neces-

sary degrees of freedom being supplied in the same or similar manner as at the sending station—namely, by means of the condensers 36, 37, and the inductance 38.

A plurality of receiver circuits, connected in parallel with respect to each other, are connected to the tuned circuit 36, 37. These receiver circuits are identical in form, each comprising a thermionic detector 40, whose input electrodes 41, 42 are connected to the tuned circuit 36, 37. The output circuit, including the electrode 43, contains the usual battery 44 and the primary of a transformer 45. The secondary of this transformer is connected in series with the condenser 46 and a translating device 47. Inductively connected to the input circuit of the detector by means of the transformer 50 is a generator of high frequency oscillations 51. This generator is so regulated that the frequency of oscillations produced thereby differs slightly from the frequencies of the generators 4, 5 and 6 at the transmitting station.

The operation of the system is as follows: Generators 4, 5 and 6, adjusted to generate oscillations of a certain definite frequency, differ the one from the other: for example—these may be 100,000, 99,600, 99,200 and so forth. Upon the closing of one or more of the signaling keys 7, oscillations of the frequencies of the corresponding generators will be impressed upon the input circuit of the amplifier 8. This amplified power will then be impressed upon the input circuit of the power amplifier 15, that is, all the power high frequency oscillations of different apparatus will be radiated simultaneously from the antenna. Upon being received at the receiving station these oscillations will combine with the locally generated oscillations, which oscillations have a definite frequency of say 100,200, and the combination of these locally generated oscillations, with the oscillations from any one generator of the transmitting station, will give oscillations which have a certain beat frequency given by the difference between the two frequencies in question. If, for example, the generator 4 has a frequency of 99,600 and signals are sent from this generator, then there will be impressed upon the input circuits of the detectors 40 high frequency oscillations which have a beat frequency of 600, and the oscillations which are then set up in the output circuit of those detectors will have a frequency of 600.

The circuits containing the translating devices are electrically tuned by means of the condensers 46 and the inductances of elements 47 in the circuits to a frequency equal to the beat frequencies. One such circuit, for example, will be tuned to a frequency of 600, another circuit will be tuned to a frequency of say 200, and so forth. Only that circuit then which is tuned to a frequency of 600 will take up or select signals transmitted from the generator 4. In this manner signals sent from any of the generators will be picked up by one and only one receiving circuit.

In order to increase the selectivity of the circuits containing the translating devices, it is desirable to have the translating device mechanically tuned to the frequency to be received. This may be accomplished in a variety of ways such, for example, as having a telephone receiver with a tuned diaphragm or by tuning forks, or by any other suitable and well-known expedient.

Fig. 3 shows a modification of the receiving circuit in which but one detector 52 is used, this detector being of the same type as those shown in Fig. 2. Connected in the output circuit of said detector 52 is a high impedance 53, and connected in shunt to such impedance 53 are a plurality of receiver circuits, each electrically tuned to a certain beat frequency and having a receiver mechanically tuned to the same beat frequency in the same manner as the receiving arrangement described in connection with Fig. 2. The modification shown in Fig. 2 has the advantage that in view of the unilateral nature of the detectors 40 there can be no back reaction from one translating circuit into another. This disadvantage in the case of Fig. 3 may be diminished by the use of such tuned weeding-out circuits as are described in patent to Stone 714,756, December 2, 1902, or other systems used for the same purpose.

It is obvious that in case the signals received are very weak, the detectors 40 and 52 may be adjusted to act also as amplifiers or that separate amplifying devices may be inserted in the circuits for this purpose.

While but three generators and receiving circuits have been shown, it is obvious that any number may be used.

In Fig. 1, a single voltage amplifier 8 has been shown which feeds by means of the transformer 14 into the power amplifier 15. It is to be understood, however, that a plurality of these voltage amplifiers 8 may be connected in series to step up to a higher voltage, in the manner described in the patents to Arnold mentioned above.

As in the ordinary case the antenna may be replaced if desired by a transmission line.

Although this invention has been described as particularly applicable to multiplex radio telegraphy, it is obvious that certain features of the invention which are covered by the appended claims are capable of application generally to energy wave transmission for signaling or selective purposes, regardless of the medium.

What is claimed is:

1. The method of transmission which

comprises simultaneously transmitting energy of a plurality of different frequencies, combining therewith energy of a different frequency and causing the combination frequencies produced thereby to selectively operate a plurality of devices.

2. The method of multiplex signaling which comprises simultaneously transmitting energy of a plurality of different frequencies, combining therewith energy of a different frequency and causing the combination frequencies produced thereby to give signal indications.

3. In a transmission system, a receiving device, means for simultaneously impressing thereon received energy of a plurality of frequencies, local means for simultaneously impressing upon said device energy of a different frequency, and individual means operative in response to beats set up by said device between said local energy and received energy of each of said frequencies.

4. In an electric transmission system, a receiving circuit, means for impressing thereon received fluctuating energy of a plurality of frequencies, local means for impressing thereon an electromotive force of a different frequency and separate means associated therewith for indicating each of a plurality of different frequency beats produced thereby.

5. In an electric transmission system, a receiving circuit, means for simultaneously impressing thereon received fluctuating energy of a plurality of high frequencies, local means for simultaneously impressing upon said circuit an electromotive force of a different high frequency and individual means for utilizing each difference frequency current produced by said received energy and said locally impressed electromotive force.

6. In an electric transmission system, a receiving circuit, means for simultaneously impressing thereon received fluctuating energy of a plurality of high frequencies, local means for simultaneously impressing upon said circuit an electromotive force of a different high frequency, and means for utilizing energy of the beat frequencies set up by the interaction of current from said local source and said fluctuating energy.

7. A signaling system comprising means for simultaneously supplying a plurality of message waves of different frequencies, means for supplying oscillations of a single frequency for combination with said waves, means for combining said waves and said oscillations, and means for utilizing the combination frequency oscillations thus produced.

8. A transmission system comprising a receiving element, means for simultaneously impressing thereupon a plurality of energy wave trains each of said trains having a frequency individual thereto, means associated with said element for combining with said received energy, locally produced oscillations of a single frequency, and individual means acting in response to the combination of each different frequency wave train with said locally produced oscillations.

9. In a multiplex radio signaling system, a receiving station adapted to receive simultaneously a plurality of messages transmitted by means of oscillations of different wave lengths, said station comprising a receiving antenna; a local generator of oscillations differing slightly in frequency from the signaling frequencies; a plurality of receiver circuits and translating devices in said circuits, each of said circuits being tuned to the beat frequency of the locally generated oscillations and the oscillations received from a corresponding sending station.

10. In a multiplex radio signaling system, a plurality of generators of low power oscillations of high but differing frequencies; signaling means for controlling said generators in accordance with signals to be transmitted; means for amplifying said oscillations; an antenna for radiating said amplified oscillations; a receiving antenna; a local generator of oscillations differing slightly in frequency from the signaling frequencies; a plurality of receiver circuits and translating devices in said circuits, each of said circuits being tuned to the beat frequency of the locally generated oscillations and the oscillations received from a corresponding generator at the sending station.

11. In a multiplex radio signaling system, a receiving station adapted to receive simultaneously a plurality of messages transmitted by means of oscillations of different wave lengths; said station comprising an antenna for receiving said oscillations; a local generator of oscillations differing slightly in frequency from the signaling frequencies; a circuit on which the received oscillations and locally generated oscillations are impressed and a plurality of receiver circuits associated with the last named circuit, each of said receiver circuits containing a detector and a translating device in the output circuit of each of said detectors, each output circuit being electrically tuned to the beat frequency of the locally generated oscillations and the oscillations received from a corresponding sending station.

12. In a multiplex radio signaling system, a plurality of generators of low power oscillations of high but differing frequencies; signaling means for controlling said generators in accordance with the signals to be transmitted; an antenna for radiating said oscillations; an antenna for receiving said

oscillations; a local generator of oscillations differing slightly in frequency from the signal frequencies; a circuit on which the received oscillations and locally generated oscillations are impressed and a plurality of receiver circuits associated with the last named circuit, each of said receiver circuits containing a detector and a translating device in the output circuit of said detector, each output circuit being electrically tuned to the beat frequency of the locally generated oscillations and the oscillations received from a corresponding generator at the sending station.

13. In a multiplex radio signaling system, a plurality of generators of low power oscillations of high but differing frequencies; signaling means for controlling said generators in accordance with signals to be transmitted; means for amplifying the oscillations; an antenna for radiating said oscillations; an antenna for receiving said oscillations; a local generator of oscillations differing slightly in frequency from the signal frequencies; a circuit on which the received oscillations and locally generated oscillations are impressed and a plurality of receiver circuits associated with the last named circuit, each of said receiver circuits containing a detector and a translating device in the output circuit of said detector, each output circuit being electrically tuned to the beat frequency of the locally generated oscillations and the oscillations received from a corresponding generator at the sending station.

14. In a multiplex radio signaling system, a plurality of generators of low power oscillations of high but differing frequencies; signaling means for controlling said generators in accordance with signals to be transmitted; a thermionic amplifier of the audion type; a radiating antenna; the input circuit of said amplifier being connected to the generators and the output circuit being inductively connected to the radiating antenna; a receiving antenna; a local generator of oscillations differing slightly in frequency from the signaling frequencies; a circuit on which the received oscillations and the locally generated oscillations are impressed and a plurality of receiver circuits associated with the last named circuit; each of said receiver circuits containing a thermionic amplifier of the audion type and being tuned electrically to the differences between the locally generated frequency and the frequency of a corresponding generator at the sending station, and a translating device associated with each of said plurality of circuits and tuned mechanically to the frequency of its circuit.

15. In a multiplex radio signaling system, a plurality of generators of low power oscillations of high but differing frequencies; signaling means for controlling said generators in accordance with signals to be transmitted; a thermionic amplifier or amplifiers, of the audion type; a radiating antenna tuned to the frequencies of the generators; the input circuit of said amplifiers being connected to the generators and the output circuit being inductively connected to the radiating antenna; a receiving antenna tuned to the frequencies of the generators; a local generator of oscillations differing slightly in frequency from the signaling frequencies; a circuit on which the received oscillations and the locally generated oscillations are impressed and a plurality of receiver circuits associated with the last named circuits, each of said receiver circuits containing a thermionic amplifier of the audion type and being tuned electrically to the difference between the locally generated frequency and the frequency of a corresponding generator at the sending station, and a translating deivce associated with each of said plurality of circuits and tuned mechanically to the frequency of its circuit.

16. In a multiplex radio signaling system, a receiving station adapted to receive simultaneously a plurality of messages transmitted by means of oscillations of different wave lengths, said station comprising a receiving antenna; a local generator of oscillations differing slightly in frequency from the signal frequencies; a plurality of receiver circuits tuned electrically to the beat frequency of the locally generated oscillations and the oscillations received from a corresponding generator at the sending station; and a translating device associated with each of said plurality of circuits and tuned mechanically to the frequency of its circuit.

17. A signaling system comprising a receiving circuit, means including frequency selective elements for simultaneously supplying said circuit with a plurality of message waves of different frequencies, local means for impressing oscillations upon said circuit, and a second receiving circuit connected to said circuit, said second circuit being tuned to the difference frequency of said oscillations and one of said message waves and additional means whereby the remainder of said message waves are caused to provide indications.

18. A signaling system comprising a receiving circuit, means including frequency selective elements for simultaneously supplying said receiving circuit with a plurality of message waves of different frequencies, means for supplying oscillations to said circuit for combination with said message waves to produce beats; a signal circuit connected to said receiving circuit, said signal circuit being

responsive to the beats corresponding to one of said message waves and means individual thereto for causing each of the remainder of said message waves to produce an indication.

19. A signaling system comprising means for supplying a plurality of messages transmitted by means of oscillations of different frequencies, means for supplying oscillations of a single frequency for combination with the oscillations of said messages, and means for receiving said messages comprising means responsive to each of said combinations.

20. In combination, means for producing a plurality of high frequency currents, means for varying each of these currents in accordance with a message, means for transmitting the energy of said varied currents to a distant station, a source of auxiliary current of frequency different from that of said varied currents, means at said distant station for combining energy from said source of auxiliary current with energy derived from said currents of other frequencies, and a plurality of selective means for simultaneously selecting different combination frequency components of said combined energy.

21. In combination, means for producing a plurality of high frequency currents, means for varying each of these currents in accordance with a message, means for transmitting the energy of said varied currents to a distant station, a local source at the distant station for supplying current of frequency different from that of said varied currents, means for combining energy from said local current source with energy derived from said currents of other frequencies, and a plurality of selective means for simultaneously selecting different combination frequency components of said combined energy.

22. In combination, means for producing a plurality of high frequency currents, means for varying each of these currents in accordance with a message, means for transmitting the energy of said varied currents to a distant station, a source of auxiliary current of frequency different from that of said varied currents, common means at said distant station for selecting energy of all of the transmitted frequencies, means for combining energy from said source of auxiliary current with energy derived from said currents of other frequencies, and a plurality of selective means for simultaneously selecting different combination frequency components of said combined energy.

23. In combination, means for producing a plurality of high frequency currents, means for varying each of these currents in accordance with a message, means for transmitting the energy of said varied currents to a distant station, a local source at the distant station for supplying current of frequency different from that of said varied currents, common means at said distant station for selecting energy of all of the transmitted frequencies, means for combining energy from said local current source with energy derived from said currents of other frequencies, and a plurality of selective means for simultaneously selecting different combination frequency components of said combined energy.

In witness whereof, I hereunto subscribe my name this 8th day of September A. D., 1915.

EDWIN H. COLPITTS.