

April 9, 1929.

H. O. PETERSON

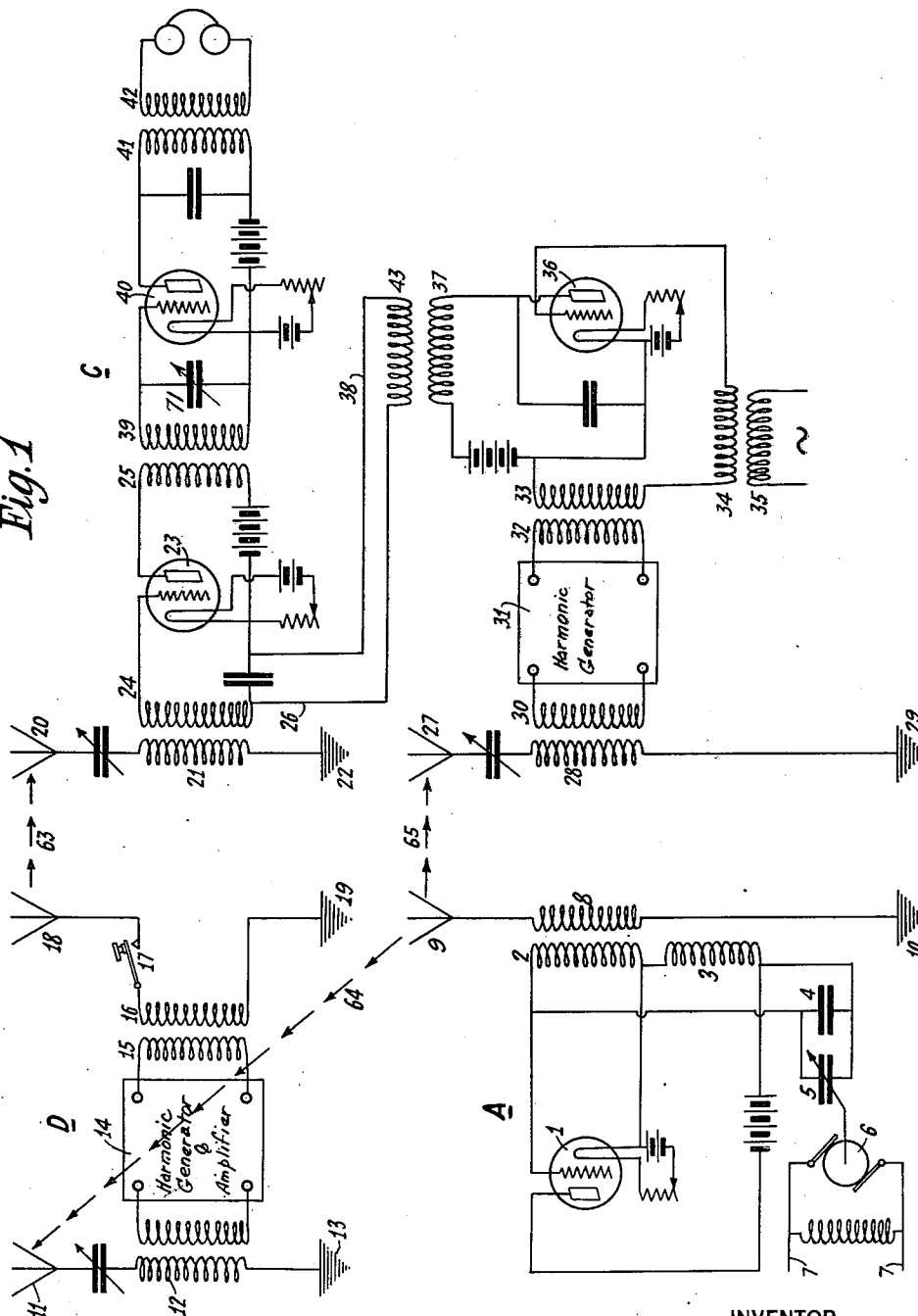
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COMMUNICATION SYSTEM

Filed June 8, 1925

2 Sheets-Sheet 1

Fig. 1



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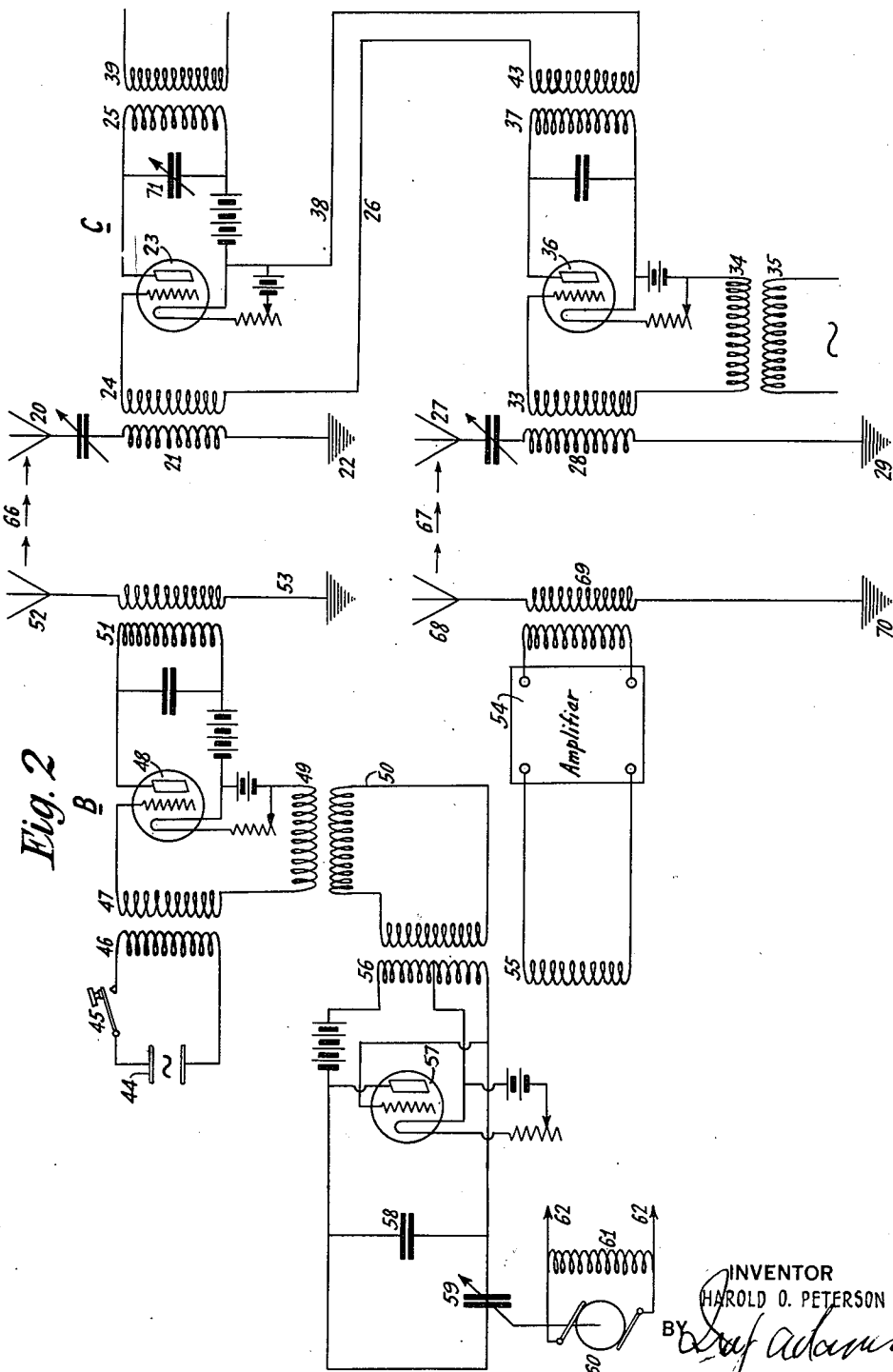
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COMMUNICATION SYSTEM.

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This invention relates to communication systems, and more particularly to wireless receiving and sending apparatus so arranged as to eliminate the deleterious effects of phenomena known as fading, static, and other disturbances which cause interruption or discontinuance of signals.

This result is accomplished by sending from a transmitter which varies or wobbles the frequency of its carrier wave, and receiving the wobbled carrier wave by a receiver the frequency of which is varied or wobbled in synchronism with that of the transmitter. To obtain the necessary synchronism a receiver is used which is controlled by the same transmitting station, or by another transmitting station common to both communicating stations. The invention may utilize not only wobbling of the frequency of a carrier channel and using the wobbled channel at the receiver, but also using a harmonic of the wobbled carrier at both the transmitter and the receiver.

For the purpose of illustration we may consider the case of transmission from station B to station C, assuming that station B has a piezo-electric crystal controlled oscillator operating at 2700 kilocycles steady frequency, and that it also has a single side band or other suitable transmitter radiating at about 186.5 kilocycles. An apparatus may be installed for wobbling the latter frequency between 186 kilocycles and 187 kilocycles at a rate of 100 cycles a second, and this wobbled frequency or a harmonic of it may then be added to the constant frequency of 2700 kilocycles by means of a balanced modulator or a detector tube. If the fundamental is added to the 2700 kilocycles frequency a new frequency band wobbling between 2886 kilocycles and 2887 kilocycles is obtained, which may be radiated from station B and received by station C. As was already stated, station B also radiates the wobbled 186.5 kilocycles frequency, which also is received at station C.

Receiving station C may have a local high frequency oscillator operating at, say 2600 kilocycles. If to this frequency the wobbled 186.5 kilocycle wave received from station B is added a new wobbled frequency is obtained wobbling between 2786 and 2787 kilocycles. This frequency is heterodyned with the high frequency received directly from station B,

giving a steady 100,000 cycle beat note as the output of the receiver. This 100,000 cycle beat frequency is steady because the 2786 kilocycle to 2787 kilocycle and the 2886 kilocycle to 2887 kilocycle frequencies wobble up and down in frequency simultaneously and synchronously. If we wish to transmit telegraphy or telephony the signals may be used to modulate the high frequency radiation at station B, and then the beat frequency at the receiver is also signal modulated. For telegraphy the beat frequency at C may be made audible, and for telephony it may be made either a sub-audible or a super-audible frequency.

As an alternative arrangement some station A may be used to transmit a common synchronizing carrier for short wave circuits operating between other stations, say, D and C. Assume that the station at A wobbles its frequency between 21,000 and 21,010 cycles per second at the steady rate of 40 cycles or wobbles per second. At station D this wobbled radiation may be received, amplified, and fed into a harmonic generator producing, as an extreme case, say, the 100th harmonic, which may be signal modulated and transmitted in the form of a short wave. In this case the carrier is a signal wobbling between 2,100,000 and 2,101,000 cycles at the steady rate of say 40 wobbles a second. Both the wobbled synchronizing fundamental from station A, and the modulated 100th harmonic radiated by the short wave transmitter at station D will be received at station C. The synchronizing carrier may be fed into a harmonic generator to obtain its 100th harmonic, some convenient steady frequency may be added to this, and the resultant frequency may be heterodyned with the received signal modulated short wave signal, so producing a steady intermediate or low frequency having the signal modulation which was impressed at the transmitter.

To simplify the resulting frequencies the short wave transmitter can be modulated with one side band and carrier suppressed in a well known manner if desired. The process of wobbling and unwobbling will be faithful in any case since both the transmitter carrier and the receiver heterodyne are wobbled up and down in frequency simultaneously and by equal amounts resulting in a

constant difference between the transmitter carrier and the receiver heterodyne.

Apparatus for obtaining these results is more specifically disclosed in the following more detailed description in connection with Figs. 1 and 2 of the annexed drawings, in which:—

Fig. 1 shows an arrangement using a separate station for synchronizing the transmitter and receiving stations, and

Fig. 2 shows the same function carried out by the transmitting station.

In Fig. 1, 1 is a master oscillator tube connected to the regeneratively coupled coils 2 and 3, which are tuned by means of condensers 4 and 5. The condenser 5 is a variable condenser connected directly or in an equivalent way to the shaft of a motor 6 energized from the line 7. The condenser 5 need not be a separate condenser but may have a multiple number of plates, one of which or a series of which may be connected to the operating shaft in order that a high frequency may be obtained. This condenser 5 being connected in parallel with the condenser 4 changes the tuning and the natural period of oscillation of the master oscillator to produce a wobbled high frequency, which is fed to the antenna coil 8 connected between the antenna 9 and the ground 10. This antenna circuit need not be a tuned circuit but may be practically aperiodic for all the frequencies within the wobble range.

The antenna circuit 11, 12 and 13 is tuned broadly enough to receive the wobbled band of frequencies, which is multiplied in the harmonic generator and transmitter 14, and fed to the transformer coil 15. This coil is coupled with the antenna system 16, 17, 18 and 19, and the output may be controlled by modulating means such as the key 17 or any other equivalent arrangement. If it is desired to use this arrangement for telephony it is only necessary to use a modulating tube in a well known manner in place of the key 17, and thereby properly modulate the energy fed from the coil 15.

The wobbled carrier radiated from antenna 9 is also received on a properly broadly tuned antenna system 27, 28 and 29 at the receiving station C. It appears in the coil 30 of the harmonic generator 31, and the harmonic of this frequency equal to that generated in the transmitter harmonic generator 14 appears in the coil 32. This coil is coupled to a coil 33 in the grid circuit of a modulator tube 36, which is also in series with the transformer 34, 35 which may be fed by a local source of difference frequency. As a result a new modulated wave appears in the transformer 37, 43 and is transmitted over the lines 26 and 38 to the detector modulator 23.

The signal modulated waves radiating from antenna 18 affect antenna system 20, 21

and 22 which is coupled to the input circuit of tube 23 by means of coil 24. Thus, in the output coil 25 there is found a new modulated wave which comprises all of the frequencies generated thus far, and their sums and differences. Among the frequencies that appear in 25 we will find one which is the difference between the wobbled frequency coupled into 24 and the wobbled frequency coupled into 43. Since these are wobbled up and down in synchronism simultaneously and by equal amounts, the difference between them will be a signal modulated steady frequency carrier which can be selected by frequency selectivity, by the aid of variable condenser 71, and thereafter used in the usual manner. This signal modulated difference frequency is fed through the coil 39 to a detector 40, and thereby produces an audio frequency signal in the output circuit 41, and so in the receiver circuit 42.

In the modification shown in Fig. 2, 44 is a constant frequency oscillator in circuit with the signal modulating means 45 and a coil 46. Coupled to the latter is a coil 47 and a modulator tube 48. The energy is modulated by energy fed to the coil 49 through a link circuit 50. In this arrangement the wobbled frequency appears in oscillator coils 56 coupled to an oscillator tube 57, the frequency of which is caused to wobble by the use of condensers 58 and 59. Condenser 59 is connected to a motor armature 60 which, together with its field 61, is fed by line 62. This wobbling frequency produced at 56 is also fed to the input coil 55 of an amplifier 54. A simple wobbled frequency is thus sent out on the antenna system 68, 69 and 70, and the wobbled frequency signal modulated energy is sent out on the antenna system 52, 53 through the coupling coil 51. These two different sets of wobbled frequencies are received on antennae circuits 27, 28, 29, and 20, 21, 22 respectively. The coil 21 is coupled with an input coil 24 of a modulator tube 23, which is also fed by lines 26 and 38 connected by means of coupling coils 43 and 37 to another modulator tube 36 which, in turn, is energized by coupling coils 28, 33 and 35, 34. Energy of fixed frequency may be fed into the coil 35, and produces a different wobbling frequency in coil 43.

All the frequencies thus far generated appear in coil 25. Among the frequencies appearing in coil 25 we will have the difference between the wobbled frequency induced in coil 43 by antenna 27 and the source coupled to coil 35, and the wobbled frequency induced in coil 24 by antenna 20. Since these two wobbled frequencies are wobbled up and down simultaneously and by equal amounts the difference between them is always the same, hence the result is a signal modulated steady frequency carrier which we can make use of in the usual manner by feeding it from

coil 39 to a suitable detector. The magnitude of this frequency depends on the relative magnitudes of the frequencies of the transmitter source 44 and the local source coupled to coil 35.

It has been found, when these frequencies are so wobbled and combined, that fading which occurs at one specific frequency at any instant will cause little or no appreciable effect on the signal as received, because often times when fading occurs at one frequency another frequency will be magnified. Various theories are presented for the explanation of this but no attempt will be made here to give a full theoretical explanation of this. This arrangement will also prevent interference by static and other electrical disturbance to some extent, especially when such a disturbance is confined to a comparatively narrow frequency band, or a single frequency. It is also found that when a receiver is used as above explained, that is, has its tuning varied within a small range, and particularly when the set is so designed that its tuning is very sharp, considerable of the disturbance from the above mentioned sources is obviated.

Other details, combinations and arrangements of these ideas may be used to advantage for the general purposes here assigned without departing from or adding to the patentable matter herein suggested. To simplify the wiring diagram the various modulators have been shown in simple form, but as was before stated, they may be of the single side band type, arranged to suppress the carrier and one side band, in which case the number of interacting frequencies will be greatly reduced. It is also apparent that more than two simultaneously wobbled channels may be used at once. For instance, all of several short wave channels to station C might be simultaneously wobbled by one wobbler, which would also be used in station C for unwobbling all of these short wave channels. It is therefore not intended to limit the scope of this invention beyond the statements embodied in the following claims:—

1. The method of communicating on wobbled carrier frequencies and eliminating the effect of the wobble of the carrier frequencies which includes generating a wobbled fundamental frequency, raising the wobbled fundamental to a wobbled harmonic frequency, modulating one of the wobbled frequencies by a desired signal, radiating the wobbled fundamental and harmonic frequencies, receiving the wobbled fundamental and harmonic frequencies, raising the wobbled fundamental to the same harmonic as the received harmonic, combining the received and locally generated harmonics to eliminate the wobble, and translating the desired signal.

2. The method of signalling which includes generating a wobbled control frequency, raising the wobbled control frequency to a har-

monic and modulating it by a desired signal, radiating the signal modulated wobbled harmonic and the wobbled control frequency, and at the receiver, receiving the signal modulated wobbled harmonic and the wobbled control frequency, raising the wobbled control frequency to the same harmonic as the signal modulated harmonic frequency, combining the signal modulated wobbled harmonic frequency and the locally generated harmonic of the wobbled control frequency to eliminate the wobble, and translating the desired signal.

3. The method of signalling which includes generating a control frequency, wobbling the control frequency, raising the wobbled control frequency to a harmonic and modulating it by the desired signal, radiating the wobbled control frequency and the signal modulated and wobbled harmonic frequency, and at the receiver, receiving the signal modulated harmonic and the wobbled control frequency, raising the wobbled control frequency to the same harmonic as the signal modulated harmonic, locally modulating it by a constant frequency, combining the signal modulated wobbled harmonic and the constantly modulated wobbled harmonic to obtain signal modulated energy of constant frequency, and detecting and translating the desired signal.

4. The method of signalling which includes: at a control station, generating a control frequency, wobbling the control frequency, and radiating the wobbled control frequency; at a transmitting station, receiving the wobbled control frequency, raising the received frequency to a harmonic and modulating it by a desired signal, and radiating the resulting signal modulated wobbled carrier; and at a receiving station, receiving the signal modulated wobbled carrier, receiving the wobbled control frequency, raising the wobbled control frequency to the same harmonic as the signal modulated carrier, combining the signal modulated wobbled carrier and the locally generated harmonic of the wobbled control frequency to eliminate the wobble, and translating the signal.

5. The method of signalling which includes: at a control station, generating a control frequency, wobbling the control frequency, and radiating the wobbled control frequency; at a transmitting station, receiving the wobbled control frequency, raising the received frequency to a harmonic and modulating it by a desired signal, and radiating the resulting signal modulated wobbled carrier; and at a receiving station, receiving the signal modulated wobbled carrier, receiving the wobbled control frequency, raising the wobbled control frequency to the same harmonic as the signal modulated carrier, locally modulating the locally generated harmonic by a constant frequency, combining the signal modulated wobbled carrier and

the constantly modulated wobbled harmonic to obtain signal modulated energy of constant frequency, and detecting and translating the signal.

6. The method of signalling which includes generating a wobbled frequency, obtaining therefrom a different frequency having a like frequency of wobble, signalling on one of the wobbled frequencies, radiating both wobbled frequencies, receiving both wobbled frequencies, combining one of the frequencies with energy of constant frequency, combining the resultant energy with the other received wobbled frequency to eliminate the wobble, and detecting and translating the signal.

7. A signalling system comprising a source of fundamental frequency, means to wobble the fundamental frequency, a harmonic generator for raising a portion of the wobbled fundamental to a harmonic frequency, a modulator for modulating one of the frequencies by a desired signal, means to radiate both of the frequencies, means to receive both of the frequencies, a harmonic generator for raising the received fundamental to the same harmonic as the received harmonic, means for combining the received and locally generated harmonic frequencies to eliminate the wobble, and means for translating the desired signal.

8. A signalling system comprising a source of control frequency, means to wobble the control frequency, a harmonic generator for raising a portion of the control frequency to a harmonic frequency, a modulator for modulating the harmonic frequency in accordance with a desired signal, means for radiating the signal modulated wobbled harmonic and the wobbled control frequency, means for receiving the radiated energy, a harmonic generator for raising the received wobbled control frequency to the same harmonic as the received harmonic frequency, means for combining the received signal modulated wobbled harmonic and the locally generated wobbled harmonic to eliminate the wobble, and means to translate the desired signal.

9. A signalling system comprising a source of control frequency, means to wobble the control frequency, a harmonic generator and a modulator for raising a portion of the wobbled control frequency to a harmonic and for modulating it by a desired signal, means for radiating the wobbled control frequency and the signal modulated and wobbled harmonic frequency, and a receiving station including means for receiving the signal modulated harmonic and the wobbled control frequency, a harmonic generator for raising the wobbled control frequency to the same harmonic as the signal modulated harmonic, a source of constant frequency, a modulator for modulating the locally generated harmonic with the constant frequency, means for combining

the signal modulated wobbled harmonic and the constantly modulated wobbled harmonic to obtain signal modulated energy of constant frequency, and means to detect and translate the desired signal.

10. A signalling system comprising a control station including means to generate a control frequency, means to wobble the control frequency, and means to radiate the wobbled control frequency, a transmitting station including means to receive the wobbled control frequency, a harmonic generator and a modulator for raising the received frequency to a harmonic and for modulating it by the desired signal, and means to radiate the signal modulated wobbled harmonic frequency, and a receiving station including means to receive the wobbled control frequency, means to receive the signal modulated wobbled harmonic frequency, a harmonic generator for raising the wobbled control frequency to the same harmonic as the signal modulated wobbled harmonic, means for combining the signal modulated wobbled harmonic and the locally generated wobbled harmonic to eliminate the wobble, and means to translate the desired signal.

11. A signalling system comprising a control station including means to generate a control frequency, means to wobble the control frequency, and means to radiate the wobbled control frequency, a transmitting station including means to receive the wobbled control frequency, a harmonic generator and a modulator for raising the received frequency to a harmonic and for modulating it by a desired signal, and means to radiate the signal modulated wobbled harmonic, and a receiving station including means to receive the wobbled control frequency, means to receive the signal modulated wobbled harmonic, a harmonic generator for raising the wobbled control frequency to the same harmonic as the signal modulated wobbled harmonic, a source of energy of constant frequency, a modulator for modulating the locally generated harmonic with the constant frequency, means for combining the signal modulated wobbled harmonic and the constantly modulated wobbled harmonic to obtain signal modulated energy of constant frequency, and means to detect and translate the desired signal.

12. A signalling system comprising a source of a wobbled frequency, means to generate therefrom a different frequency having a like frequency of wobble, a modulator for modulating one of the wobbled frequencies by a desired signal, means to radiate both wobbled frequencies, means to receive the radiated energy, a source of constant frequency, means to combine the constant frequency with one of the received wobbled frequencies, means to combine the resultant with

the other received wobbled frequency to eliminate the wobble, and means to detect and translate the desired signal.

13. A signalling system comprising a source of fundamental frequency, means to wobble the fundamental frequency, a harmonic generator for raising a portion of the wobbled fundamental to a wobbled harmonic frequency, a modulator for modulating one of the wobbled frequencies by a desired signal, independent antenna systems for radiating each of the wobbled frequencies, independent receivers for each of the wobbled frequencies, a harmonic generator for raising the received wobbled fundamental to the same harmonic as the received wobbled harmonic, means for combining the received and locally generated wobbled harmonics to eliminate the wobble, and means for translating the desired signal.

14. A signalling system comprising a source of control frequency, means to wobble the control frequency, means to radiate a

portion of the wobbled control frequency, a harmonic generator and modulator for raising another portion of the wobbled control frequency to a harmonic and for modulating it by a desired signal, means for radiating the signal modulated wobbled harmonic, and a receiving station including independent means for receiving the signal modulated wobbled harmonic and the wobbled control frequency, a harmonic generator for raising the wobbled control frequency to the same harmonic as the signal modulated harmonic, a source of constant frequency, a modulator for modulating the locally generated harmonic with the constant frequency, means for combining the signal modulated wobbled harmonic and the constantly modulated wobbled harmonic to obtain signal modulated energy of constant frequency, and means to detect and translate the desired signal.

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