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REDUCTION OF ATMOSPHERIC INTERFERENCE

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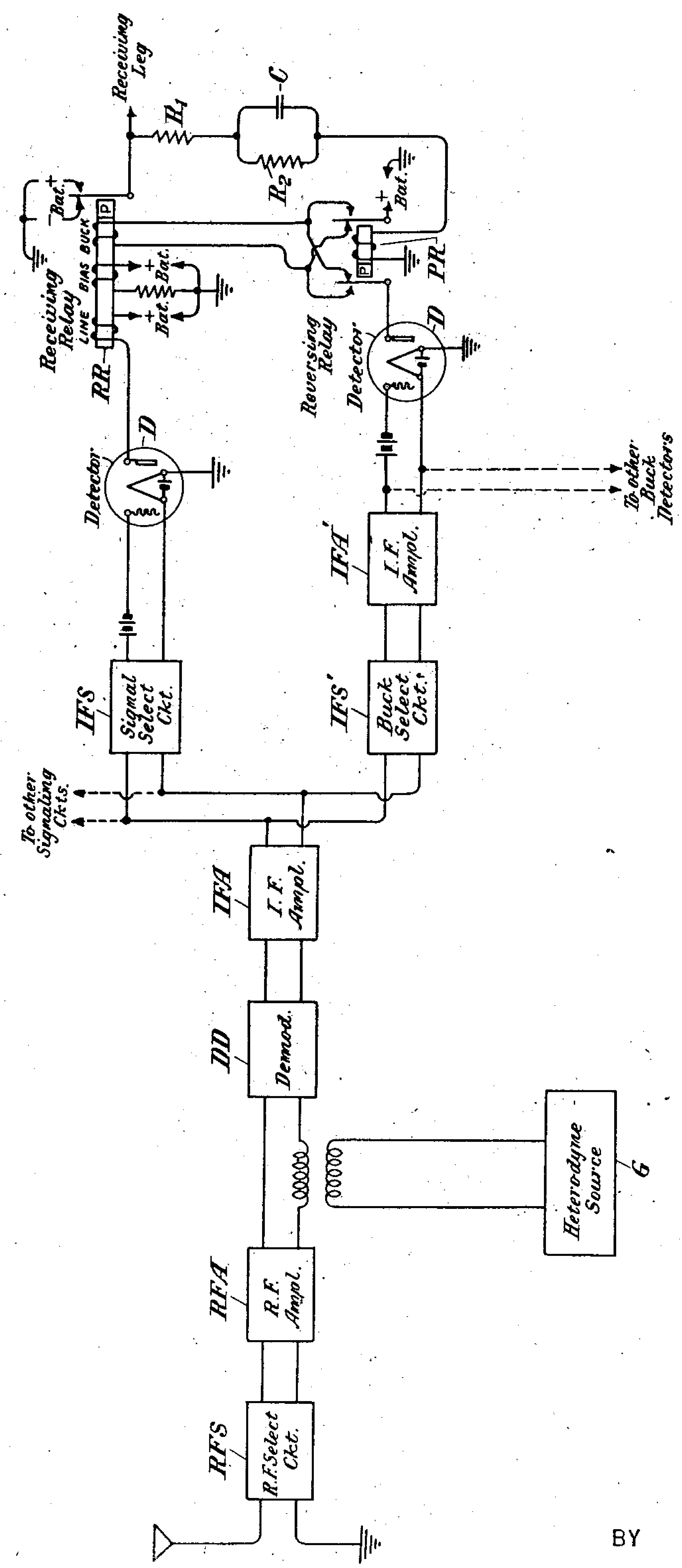

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REDUCTION OF ATMOSPHERIC INTERFERENCE

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This invention relates to radio or wire telegraph systems, either radio or on wires and more particularly to arrangements for suppressing atmospheric disturbances in such systems.

In accordance with the present invention, it is proposed to utilize, in connection with a double demodulation receiving arrangement, a so-called "buck" channel which tends to prevent false signals upon the part of the receiving relay due to components of the atmospheric disturbance which finally reach the receiving channel.

The double demodulation feature reduces the effect of atmospheric disturbances by limiting the frequency components which are effective upon the final detector to the frequency range assigned to the receiving channel or channels. Its operation is to first select, so far as is possible at the high receiving frequency, the range of frequencies desired. Sharp selection is not possible at this stage, and hence atmospheric or other interfering components lying somewhat outside the desired range will also be received by the selecting circuit. The selected range is then stepped down by demodulation to a lower position in the frequency spectrum, and the desired band width for the receiving channel or channels is again selected by means of a filter or tuned circuit. Due to the lower position of the desired band in the frequency spectrum after being stepped down, it is possible, at this stage, to more sharply select the wanted frequencies from those which are undesired so that, so far as atmospheric disturbances are concerned, the only components which will affect the final detector are those which lie substantially within the desired band.

As to these components (which cannot be eliminated by selection), the "buck" circuit goes into play to neutralize or prevent their effects upon the receiving relay. The "buck" circuit comprises an auxiliary channel associated with the receiving channel beyond the demodulator which steps down the frequency to its intermediate range, such channel being selective of a frequency different from that of the receiving channel or channels but closely related thereto. No carrier is supplied at this frequency from the distant transmitting station, but when an atmospheric disturbance occurs which has frequency components corresponding to the auxiliary channel, such components are selected and rectified in the auxiliary channel, to produce a current impulse which is applied to the auxiliary winding of the receiving relay, in such a direction as to tend to hold the armature against the contact upon which it happens to rest at the moment the disturbance occurs. In order that the current impulse be applied in the proper direction, a reversing relay is provided which shifts the direction of the impulse as the received signal changes from marking to spacing, and vice versa.

In general, the double demodulation arrangement and the "buck" circuit arrangement supplement each other so far as discriminating against atmospheric disturbances is concerned. The effect of the double demodulation arrangement may be briefly stated to be one of discarding from the band of disturbing frequencies all those lying without the wanted signal range. The "buck" circuit then goes into play to neutralize the effect of those components of the disturbance which lie within the wanted range.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawing the figure of which illustrates schematically a circuit arrangement embodying the invention.

The apparatus for practicing the invention comprises a selecting circuit RFS whose input may be connected to any high frequency receiving circuit such as a high frequency transmission line or radio antenna. For the purpose of illustration the selecting circuit is shown associated with an antenna. In the case of a radio system this selecting circuit may be a tuned circuit. The output side of the selecting circuit is connected to a radio frequency amplifier RFA, which may be of the well known vacuum tube type, for amplifying the selected band of frequencies. The output of the amplifier is connected to a demodulator DD whose input circuit is also associated with a heterodyne source G. The demodulator DD may be of any known type of vacuum tube demodulator and the heterodyne source G may, for example, be a vacuum tube oscillator. An intermediate frequency amplifier IFA is connected to the output side of the demodulator DD, this amplifier being of any known type such, for example, as a vacuum tube.

If the system is a multiplex system, the output of the intermediate frequency amplifier IFA is connected to various selecting circuits, such as IFS, of the several channels, the apparatus of only one channel being illustrated. The selecting circuit IFS may be a tuned circuit, band filter or other known type of selecting arrangement arranged to select from the output of the amplifier IFA the desired band of frequencies for the particular receiving channel illustrated.

The receiving channel includes, in addition to the selecting circuit IFS, a vacuum tube detector D whose grid circuit is biased by means of a C battery or otherwise in such manner that, in the absence of a high frequency carrier current, no current flows in the plate circuit. The plate circuit is connected to the B battery through the line winding of the receiving relay RR. The receiving relay also is provided with a biasing winding which tends to normally hold the armature of the relay against its spacing contact. The apparatus is so adjusted that when a carrier current corresponding to a marking signal is applied to the grid of the detector D, the plate current flowing through the line winding of the receiving relay will produce a pull on the armature, tending to shift it to its marking contact with a force about twice as great as that produced by the biasing winding.

The "buck" channel includes a selecting circuit IFS′ which may be similar to the selecting circuit IFS previously described. This selecting circuit should be selective of a frequency closely related to the carrier frequencies assigned to the several signal channels as they appear after being stepped down by the demodulator DD. The "buck" channel also may include an intermediate frequency amplifier IFA′ of any known type such as, for example, a vacuum tube amplifier, for the purpose of increasing the magnitude of the "bucking" impulses, as will be described later.

The selecting circuit IFS′ and amplifier IFA′ of the "buck" channel are common to the neutralizing impulses of several receiving channels, where the system is multiplexed. The output circuit of the amplifier IFA′ is connected to a plurality of detectors such as D′, one corresponding to each receiving channel. The detector D′ may be in all respects similar to detector D, and has its grid biased in the manner already described so that no current normally flows in the plate circuit. The plate circuit of the detector D′ is connected to the B battery over the contacts of a reversing relay PR and through the "buck" winding of the receiving relay RR.

The reversing relay PR, which is a polar relay, is connected in a leak circuit associated with the receiving leg, said leak circuit comprising a resistance R_1 in series with a parallel combination of resistance R_2 and capacity C. By this arrangement the reversing relay is controlled by the armature of the receiving relay as it is shifted from marking to spacing, and vice versa. By means of its armature the reversing relay PR reverses the direction of the plate current of the detector D′ through the "buck" winding so that the impulse of current in the plate circuit caused by an atmospheric disturbance will always be in such a direction as to tend to hold the armature against the contact upon which it rests at the moment the disturbance occurs. The resistances R_1 and R_2, together with the capacity C, serve to accelerate the action of the polar relay PR. At the beginning of a signal wave originated by the armature of the receiving relay RR in the receiving leg, the capacity C acts substantially as a short-circuit for the resistance R_2, so that the current through the reversing relay will have a sharp peak at the beginning of the pulse. As the capacity C charges up, current begins to flow through the resistance R_2, so that the current through the reversing relay drops off to a value determined by the resistances R_1 and R_2 in series with the resistance of the polar relay PR.

The operation is as follows: Assuming that the system is operated on a multiplex basis, the selecting circuit RFS is arranged to freely pass a band of frequencies wide enough to encompass the frequencies assigned to the several receiving channels and, in addition, the frequency assigned to the "buck" channel. The selecting device discriminates, so far as possible, against frequencies lying outside the desired band. At radio frequencies, however, it is impracticable to design a selecting circuit, such as RFS, which will sharply discriminate between the desired band and those frequencies lying outside, so that the desired band, together with some unwanted frequencies, will necessarily be impressed upon the amplifier RFA. The amplified waves are then applied to the demodulator DD, together with the frequency generated by the heterodyne source G. This frequency is so related to the received band as to produce in the output of the demodulator a side band comprising sub-bands corresponding to each of the signal bands but shifted in the frequency spectrum to a low position. The waves from the output of the demodulator DD are then amplified by the intermediate frequency amplifier IFA.

The waves appearing in the output of the intermediate frequency amplifier comprise a frequency range corresponding in width to that passed by the selecting circuit RFS, but as this band is now located at a lower point in the frequency spectrum, it is relatively much easier to sharply select the desired frequencies from the unwanted frequencies. The selecting circuit IFS, therefore, selects from the intermediate frequency range the desired sub-band of frequencies assigned to its particular channel and, similarly, the selecting devices for the other signal receiving channels select their particular sub-bands.

If no atmospheric disturbance is occurring, no frequency will appear corresponding to the selecting circuit IFS′ of the "buck" channel, and hence the "buck" channel takes no part in the operation. The band selected by the selecting circuit IFS, however, is impressed upon the detector D so that in the plate circuit of the latter a current will flow through the line winding of the receiving relay RR for each group of high frequency waves corresponding to a marking signal, but no current will flow during the spacing signal. The armature of the receiving relay RR is accordingly shifted from marking to spacing, and vice versa, as the received signals change in character, thereby transmitting corresponding direct current signals to the receiving leg.

If an atmospheric disturbance occurs, such disturbance will usually manifest itself as a sharp sudden wave whose frequency components extend over a very wide range. If none of these frequency components falls within the range of frequencies corresponding to the several signal channels being received, the intermediate frequency demodulating portion of the system will result in a practically complete suppression of the disturbance because the disturbing waves will be shifted down in the frequency spectrum by the demodulator DD so that the sharply selective circuit, such as IFS, will be able to reject the undesired frequency components. If, however, there are frequency components in the disturbing wave which fall within the range of frequencies covered by signal channels, such waves will be passed by the selecting circuit RFS which may also partially, though perhaps not entirely, suppress other undesired waves lying on either side of the range assigned to the useful signals. These components are amplified and demodulated by the amplifier RFA and the demodulator DD, along with the desired signal waves, and with the latter are stepped down in the frequency spectrum. The amplifier IFA then amplifies the stepped-down waves and each selecting circuit, such as IFS, selects its band of frequencies, together with such interfering components as fall within its particular range. Similarly, the selecting circuits IFS′ of the "buck" channel will select components of the interfering wave corresponding to its assigned range but will select no carrier or signal components as no such components corresponding to the "buck" channel are transmitted from the distant station.

The effect of the interfering frequencies selected by the circuit IFS will depend upon whether a marking signal or spacing signal is being received at the time of disturbance. If a spacing signal is being received so that normally no plate current is flowing through the line winding of the relay RR, the effect of the disturbing frequencies is to cause a plate current to flow, thereby causing a false marking signal during the spacing interval. If, however, a marking signal is being received, the effect of the interfering frequencies will cause either an increase or a decrease in the plate current, depending upon the magnitude of the interfering wave. An increase in the plate current of the detector D is without harmful effect, so far as causing a false signal is concerned, but if the plate current is materially decreased as a result of the interfering wave a false spacing signal might occur during the marking interval.

The effect of the "bucking" channel, however, is to prevent false signals of either of the types above referred to. Regardless of whether a spacing signal or a marking signal is being received by the signal channel or channels, the "buck" channel receives the interfering wave components corresponding to the selecting circuit IFS′, and these waves are amplified by the amplifier IFA′ and applied to the detector D′ of the particular channel illustrated (and to other similar detectors when the system is multiplexed). This causes a current to flow in the plate circuit of the detector D′ where normally no current should flow. This pulse of current passes through the "buck" winding of the receiving relay RR over the contacts of the reversing relay PR in a direction depending upon whether a marking signal is being received or a spacing signal. If a marking signal is being received the reversing relay will have its armatures resting against its front contacts, as shown, so that the pulse of current from the plate circuit of the detector D′ will be in such a direction as to tend to hold the armature of the receiving relay RR upon its marking contact notwithstanding the decrease in the plate current through the line winding. If a spacing signal is being received the reversing relay will have its armatures resting against its back contacts, and the direction of current through the "buck" winding will be reversed so as to tend to hold the armature against the spacing contact notwithstanding the false signal current through the line winding. The amplifier IFA′ is provided in order to increase the amplitude of the "bucking" impulse which results from an interfering wave, so that even when the components of the interfering wave which correspond to the "bucking" channel are relatively weak as compared to those components which enter the signal channels, the current impulse in the plate circuit of the detector D′ will be large enough to hold the armature upon the contact against which it rests in spite of the false signal current through the line winding of the relay RR.

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 high frequency telegraph system, the method of suppressing atmospheric interference which consists in selecting a band of frequencies corresponding to the desired signal while partially suppressing interfering frequency components lying without said band, stepping down the resultant frequency components to a lower range in the frequency spectrum, selecting the band corresponding to the desired signal in its lower range while practically suppressing frequencies outside the band, detecting from the selected band signal pulses to actuate a receiving relay, selecting from frequencies in the lower range a component corresponding to the interfering wave and having a frequency in the neighborhood of the desired signal band in the lower range, translating the selected component into a pulse of current, and producing by said pulse of current a force tending to hold the armature of the receiving relay upon the contact against which it happens to rest when the interfering wave occurs.

2. In a high frequency telegraph system, means to select at high frequency a band of frequencies corresponding to a desired signal while at least partially suppressing interfering frequencies outside the band, means to step down the resultant frequency components to an intermediate frequency range, means to select in the intermediate frequency stage the desired signal band to the exclusion of interfering frequencies without the band, means to detect from the selected signal band direct current pulses corresponding to telegraph signals, a receiving relay responsive to said pulses, a buck channel including means to select at the intermediate frequency stage interfering components of frequency closely related to the desired signal band, means to produce therefrom a pulse of current, and means to produce from said pulse a force tending to hold the armature of the receiving relay upon the contact against which it happens to rest when the interfering wave occurs.

3. In a high frequency telegraph system, means to select at high frequency a band of frequencies corresponding to a desired signal while at least partially suppressing interfering frequencies outside the band, means to step down the resultant frequency components to an intermediate frequency range, means to select in the intermediate frequency stage the desired signal band to the exclusion of interfering frequencies without the band, means to detect from the selected signal band direct current pulses corresponding to telegraph signals, a receiving relay responsive to said pulses, a buck channel including means to select at the intermediate frequency stage interfering components of frequency closely related to the desired signal band, means to produce therefrom a pulse of current, an auxiliary winding of said receiving relay through which said pulse is caused to flow, and means to reverse the effective direction of said pulse with reversals in the character of the signal so as to hold the armature of the relay upon the contact against which it happens to rest when the interfering wave occurs.

4. In a high frequency telegraph system, means to select at high frequency a band of frequencies corresponding to a desired signal while at least partially suppressing interfering frequencies outside the band, means to step down the resultant frequency components to an intermediate frequency range, means to select in the intermediate frequency stage the desired signal band to the exclusion of interfering frequencies without the band, means to detect from the selected signal band direct current pulses corresponding to telegraph signals, a receiving relay responsive to said pulses, a buck channel including means to select at the intermediate frequency stage interfering components of frequency closely related to the desired signal band, means to produce therefrom a pulse of current, an auxiliary winding of said receiving relay through which said pulse is caused to flow, a reversing relay controlled by said receiving relay, and means controlled by said reversing relay to effectively reverse the direction of flow of said pulse through said winding as the character of the received signal changes.

5. In a high frequency telegraph system, means to select at high frequency a band of frequencies corresponding to a desired signal while at least partially suppressing interfering frequencies outside the band, means to step down the resultant frequency components to an intermediate frequency range, means to select in the intermediate frequency stage the desired signal band to the exclusion of interfering frequencies without the band, means to detect from the selected signal band

direct current pulses corresponding to telegraph signals, a receiving relay responsive to said pulses, a buck channel including means to select at the intermediate frequency stage interfering components of frequency closely related to the desired signal band, means to amplify said interfering components, means to produce therefrom an amplified pulse of current, and means to produce from said pulse a force tending to hold the armature of the receiving relay upon the contact against which it happens to rest when the interfering wave occurs.

In testimony whereof, I have signed my name to this specification this 24th day of November, 1928.

LEO A. KELLEY.