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DOUBLE-CURRENT AUDIO-FREQUENCY TELEGRAPHIC TRANSMISSION SYSTEM

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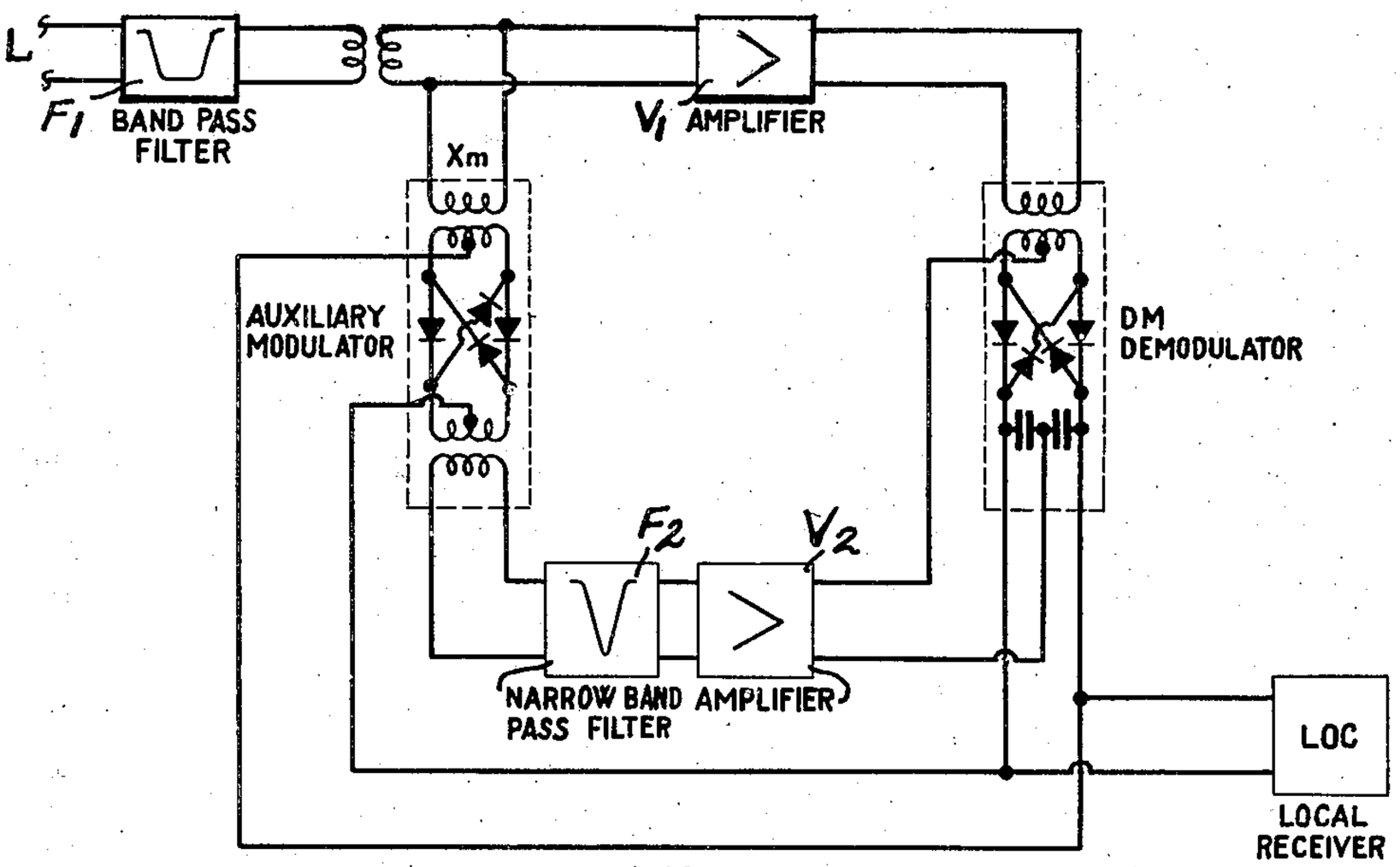

Fig. 1.

(PRIOR ART)

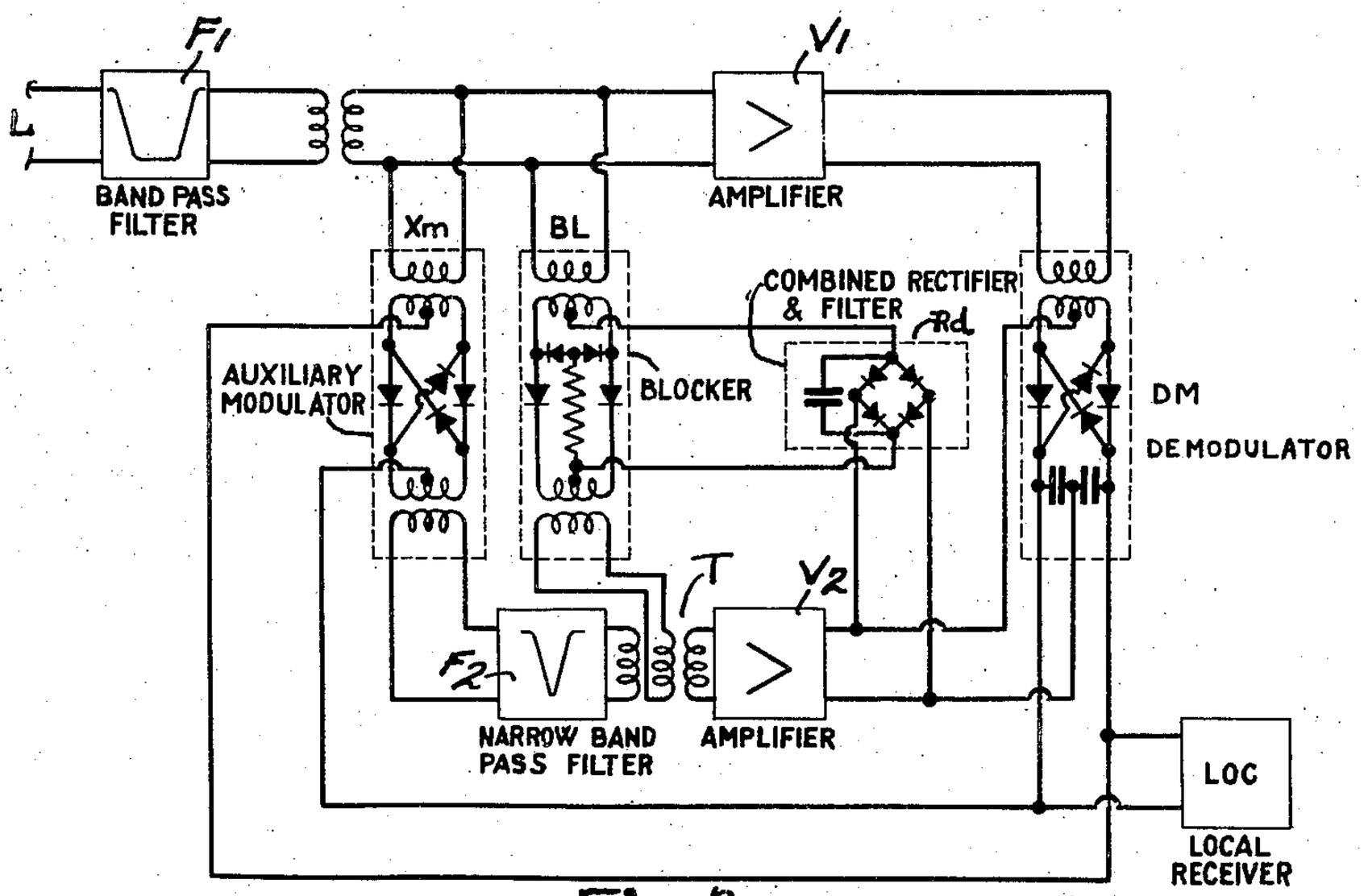

Fig. 2

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DOUBLE-CURRENT AUDIO-FREQUENCY TELEGRAPHIC TRANSMISSION SYSTEM

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1

The present invention relates to double current telegraph transmission circuits using a code of two elements or trains, of which the first consists of a transmission of signals of a carrier of audio-frequency and the second of audio frequency signals of the same frequency but 180° out of phase. It is well known that, as described in French Patent No. 803,109, that in such systems which are called audio-frequency telegraph transmission systems with phase inversion, the telegraph signals are reconstituted at the receiver by demodulation of the received wave by means of a reconstituted carrier wave used for demodulating. The reconstituted carrier wave is necessary because without it, one cannot at the receiving station arrange to provide a phase for comparison to permit of interpreting the signals received.

According to whether the phase of the reconstituted carrier wave is correct or not, so the succession of reconstituted signals obtained will be a faithful reproduction or the inverse of that of the signals transmitted.

To ensure agreement, it is necessary that the carrier wave serving for demodulation is initially started off with a phase or sense or polarity predetermined with relation to the first received wave, which determines the direction or sense or polarity of the first reconstituted telegraph current impulse obtained, which direction can be chosen beforehand to be identical with that which will be suitable for the first impulse transmission.

While thus ensuring at the end of the transmission the identity of the signals transmitted and obtained—the first transmission may be chosen as a neutral signal—the correct reception of any succession of signals whatever is assured provided the circuit is not broken. To satisfy this condition, the present invention has for its object a method of poling the initial phase of the carrier wave reconstituted at the receiver and is characterised in that in order to obtain demodulation, the incident wave is combined with an auxiliary wave during the reception of the first train of waves.

In such a double current system of telegraph transmission, the sending station comprises a modulator at the control terminals of which the telegraph code transmitter applies a control current which is at certain instants a "rest" current of one polarity, and at other instants a marking or operating, or "work" current of opposite polarity. The inversions in polarity of this control current has for its effect to invert the phase

2

of the telegraph current sent in the line, every change of polarity of the control current causing an inversion of phase of the telegraph line current.

To each character transmitted, there corresponds, therefore, the application to the modulator of a succession of pulses of alternating current which are alternately rest currents and work currents, according to a determined code, and, hence, correspond to the transmission on the line of a succession of currents of phases which are alternately inverted.

For example, in the International start-stop code, to the letter "S" there corresponds, after the sending of a "work" or marking current pulse corresponding to the start, the transmission, during an elementary interval, of a "rest" current, then, during the following interval, of a "work" current, then during a following interval of a "rest" current, then during two following successive intervals of a "work" current, and, thereafter, finally of a "rest" current corresponding to "stop." To each one of these inversions there corresponds a change of the phase of the current which was sent on the line, there being five changes of phase in the course of the transmission of the letter S.

At the receiving station, there is applied to a demodulator, on the one hand, the received current received at the end of the line, including its inversions of phase, and, on the other hand, the reconstituted carrier frequency current as it has been set up in the line at the beginning of the transmission, but maintaining its initial phase without any change. Thus, the current delivered from the output terminals of the receiving demodulator will change in sense or direction at the same time that the telegraph current in the line will change its phase.

Hence, it can be said that every change of sense or direction of the current taken off at the output terminals of the demodulator of the receiving station corresponds to a change of sense or direction of the current applied to the control terminals of the demodulator of the transmitting station. But, on first consideration, it cannot be known whether to a given received pulse of "rest" current, there corresponds, at the transmitting station, a pulse of "rest" current or a pulse of "work" current.

In order to assure agreement between the senses or directions of the original currents of reception and those of transmission, provision is made so that the first current pulse taken off at the output of the demodulator of the receiving

station can be of only one determined sense or direction, and it will always be provided that the transmission will be commenced by the sending of a current of this same determined sense or direction, for example, a rest current pulse, if it has been arranged that the demodulator of the receiving station shall, on its first pulse, deliver initially a rest current.

The present invention has for an object to provide means for unambiguously determining at the receiving station, the phase of the current at the output of the demodulator when this receiving station receives a first signal pulse after an interruption of the current in the line has occurred, due to any circumstances.

The present invention is applicable to a known type of system wherein there is used for the reconstituting of the carrier current, an auxiliary modulator energized, on the one hand, by the signals received at the end of the telegraph line, and, on the other hand, by the signals delivered at the output of the principal demodulator. Such a system has been described in British Patent 449,999, and the corresponding U. S. Patent 2,108,117 of Gardere and Pages.

In order to assure with such a system the establishment at the output of the auxiliary modulator of the re-constituted carrier current, it is necessary that, in the absence of current delivered at the output of the principal demodulator, which current is applied to the control terminals of the auxiliary modulator, that this latter auxiliary modulator should furnish at its output terminals a current of phase which is definitely determined with relation to the current at its input terminal.

In the mentioned system of the Gardere and Pages patent, this result is obtained by causing a dissymmetry in the auxiliary modulator by a choice of uni-directional conducting elements of different characteristics. There arises herefrom, however, a variation of the reconstituted carrier current according to the direction of the current applied to the control terminals, that is to say, according to the sense or polarity of the signal pulses. The present invention provides a device which permits attaining these same results without it being necessary to introduce dissymmetry into the auxiliary modulator.

The present invention is characterized by the fact that it comprises, for the supplying of the control circuit of the principal demodulator at the instant of the arrival at the end of the line of the first signal current pulse, a derived circuit taken off the said line, and by which the received current is fed to this control circuit through the means of a blocker whose blocking control voltage is taken through a low pass filter from the output terminals of a rectifier supplied by the reconstituted carrier voltage.

The present invention will be better understood by referring to the accompanying drawing which illustrates circuits by which the method according to the present invention can be realised.

Fig. 1 is a standard circuit arrangement in audio-frequency telegraphy using phase inversion as used in the prior art.

Fig. 2 illustrates the same circuit arrangement modified in accordance with the present invention.

In the conventional arrangement of the prior art shown in Fig. 1, the signals coming over the line L toward the receiving station, traverse in addition to the bandpass filter F_1, the amplifiers V_1 and V_2, the demodulator DM, the auxiliary modulator Xm and the narrow bandpass filter F_2.

To the output of demodulator DM the local receiving circuit LOC is connected, which circuit consists of a telegraph receiver or an intermediate relay. The demodulator DM uses for demodulation the reconstituted carrier frequency output of auxiliary modulator Xm which permits the obtaining of the original direct current double current double current d. c. signals. These are the signals which by modulating the incident wave derived from the line and incident on auxiliary modulator Xm reconstitute the carrier at the output of auxiliary modulator Xm, the narrow band-pass filter F_2 of relatively long time constant serving to preserve the phase for a sufficient time to permit the telegraph current to become inverted.

If in the prior art arrangement of Fig. 1 the auxiliary modulator Xm was perfectly symmetrical, reception could not be obtained. It is therefore necessary to give said auxiliary modulator Xm a definite bias during non-operating conditions.

According to the present invention one applies to the input of amplifier V_2 without passing through narrow band filter F_2, in addition to the voltage derived from the output of the bandpass filter F_1, the voltage derived from the incident signals coming in on the line and passing through a blocking device BL having a slight attenuation during non-operating conditions but which during actual signal transmission can be blocked as soon as the normal energization of amplifier V_2 by an auxiliary modulator is assured, either by the telegraph current corrected and filtered by a low-pass filter or by derivation from the demodulated carrier wave taken from the output of amplifier V_2.

Such blocking is able to bring about in known blocking systems an attenuation of 5 nepers, and the lack of symmetry applied to the input of amplifier V_2 according to the laws of blocking is without importance. A "blocker" may, for the present purposes, be considered to be a quadripole having attenuation and cut-off characteristics controlled by an applied controlled current which can be realized with dry rectifiers arranged in known circuit arrangements.

It will be borne in mind that what one calls a blocking device is a bridge network or quadripole having its attenuation regulated by a control current which can be obtained by means of dry rectifiers arranged in accordance with known circuit arrangements.

Fig. 2 shows the arrangement of Fig. 1 modified according to the preceding description. The control of the blocking action of blocking device BL is effected by means of the carrier wave derived from the output of amplifier V_2 and rectified by means of a device Rd which is a combined rectifier and filter. The advantage of this arrangement is that one can obtain a substantially constant blocking current by a simple filter.

Auxiliary modulator Xm may consist of a rectifier bridge as may also demodulator DM. Blocker BL may consist of a rectifier quadripole. Combined rectifier and filter Rd may consist of a rectifier unit quadripole with a condenser connected across to opposite corners. The amplifier V_2 may have its input transformer coupled by a transformer having two primaries respectively connected to the outputs of blocker BL and filter F_2.

The initial signal passes directly from the line through blocker BL to the input of amplifier V_2 without passing through filter F_2, since there is

at that instant no output of amplifier V_2 to be rectified by rectifier R*d* and then applied to the control terminals of blocker BL to cause blocking action. An instant later the portion of the signal derived from the line and traversing auxiliary modulator X*m* and filter F_2 has reached amplifier V_2, whose rectified output of the first signal pulse through the blocker and subsequent pulses through the filter are delayed somewhat in passage to rectifier R*d*, is then applied to the control terminals of blocker BL to block it. By the time the initial signal element has had time to pass through the unactuated blocker and the amplifier V_2 and the rectifier R*d*, to the control terminals of blocker BL to block it, the next signal element through demodulator DM and filter F_2 has had time to establish itself, and the path through blocker BL is no longer needed. In this way, the initial signal element passing through the blocker BL controls the first signal pulse delivered.

The blocking device BL is connected between the output of band pass filter F_1 and the input of modulator V_2. The initiation of this control current from amplifier V_2 through device R*d* is made sufficiently slow and smooth so that at the moment when it causes suppression of the signal at the output of blocking device BL, the normal energization of amplifier V_2 by auxiliary modulator X*m* through narrow band pass filter F_2 has been able to establish itself.

If on the other hand it was desired to use the telegraph current taken from the output of DM and rectified, it would be necessary to compensate for the variations in the transmission from one signal pulse to another signal which it is not possible to attain by means of an inertialess blocking device; a filter having a time constant lying between one-half and the full value of the time constant of the audio-frequency filters gives a reduction of about one half of the rectified current in the transmission from one signal pulse to another. It is necessary that this reduction still permits of a very slightly attenuated blocking in order that the blocking device BL may not be the cause of certain difficulties arising.

Care is taken to provide a suitable condition of the impedances in the arrangement of Fig. 2, so that under the operating conditions, when the blocker BL is blocked, this blocker delivers practically no energy to the input of amplifier V_2 and so that when unactuated and not blocking, when its attenuation is small, the blocker BL does not constitute an impedance which is so small as to involve the risk of draining off too large a fraction of the energy available at the input of amplifier V_2. Suitable values of impedance are easy to realize through familiar procedures of current technique.

The rectifier R*d* should represent an impedance of sufficiently great magnitude to not drain off too large a fraction of the energy available at the output of amplifier V_2, and of such value as to furnish, when the re-constituted carrier wave at the output of amplifier V_2 has its normal amplitude, a rectified voltage which is of sufficient magnitude to assure the blocking of blocker BL.

The blocking device BL is of a known type and is designed to have slight attenuation in the absence of the application of control current from the output of amplifier V_2 through device R*d*. When the control current is applied to the blocking device BL, however, its attenuation can attain a value as high as five nepers. The dissymmetry resulting therefrom is not important under normal operating conditions.

The output of the narrow band pass filter F_2 feeds through a transformer T, the input of the amplifier V_2. This transformer T comprises two primary windings and a secondary winding, this latter feeding the input of the amplifier V_2 while one of the primary windings is energized from the output of narrow band pass filter F_2. The other primary winding is connected to the output of blocking device BL. It is well understood that care has to be taken to obtain suitable impedance characteristics in order that in the position where it is blocked, the blocking device BL shall drain practically no energy at all from the input of the amplifier V_2 and in order that in its non-operative condition, where the attenuation is small, the blocking device BL does not constitute too low an impedance with the risk of reducing by too great a fraction the energy available at the input of amplifier V_2. Suitable impedance characteristics can be easily provided by methods well-known in the present state of the art.

So, the rectifier R*d* should represent a sufficient impedance in order not to reduce by an excessive fraction the energy available at the output of amplifier V_2 and to furnish when the reconstituted carrier at the output of amplifier V_2 has its normal amplitude, a rectified voltage sufficient to ensure the blocking of blocking device BL.

In arrangements such as that described, the output modulator is usually arranged in a circuit at the output of the amplifier V_2 and is supplied with a reconstituted carrier wave (it can besides be, and it is generally the case that one of the communicating stations is supplied with energy from a local generator); in the absence of control current, this modulator ought to have a definite condition.

Immediately after receiving the beginning of the first signal, the signal supplied by the auxiliary modulator X*m* is delayed, as has been shown, by the filter F_2. The control circuit of the blocking device BL is, therefore, not energized; this is then "open" and allows the incident signal to pass on to the control circuit of demodulator DM. Demodulator DM thus receives the said incident signal at the same time at both its input and control circuits; the conditions of agreement of phase are, therefore, automatically realized and demodulator DM yields a signal of correct phase at its output.

Auxiliary modulator X*m* is then supplied, in its turn, at its control circuit with the correct signal from demodulator DM; it, therefore, delivers at its output terminals, a signal in phase with the signal at its input terminals. When the retarding effect of the filter F_2 is no longer felt, the output auxiliary signal of modulator X*m* is delivered to the control circuit of demodulator DM instead of the signal through blocker BL which is blocked since its control circuit is now energized.

It is obviously necessary that blocker BL should not be blocked before the signal from auxiliary modulator X*m* has had time to reach demodulator DM. This is why the arrangement including rectifier R*d* comprises, in addition to a rectifier, a filter having a time constant longer than that of F_2. So, as long as the filter F_2 blocks the signal from auxiliary modulator X*m*, the control circuit of blocker BL is not energized and blocker BL allows the incident signals to pass.

Afterwards, blocker BL does not play any part, being permanently blocked in normal operation by

the re-established carrier wave from auxiliary modulator X*m* which energizes its control circuit; blocker BL, therefore, only serves at the moment of commencing to receive the first signal.

The control circuit of blocker BL could equally be supplied by the telegraph current taken from the output of demodulator DM and rectified, but it would then be necessary to compensate the variations in this current which are produced in passing from one signal to another and which would influence the operation of the blocking device; by reason of its absence of inertia; this compensation would entail complicated arrangements.

Care must be taken to achieve suitable impedance conditions such that when the blocking device BL is "closed" it takes substantially no energy from the input of the amplifier V_2 and when it is "open" it takes only a reduced fraction of the available energy at the input of this amplifier.

Also, the rectifier R*d* should have sufficient impedance not to take an excessive fraction of the energy available at the input of V_2 and supply, when the output current of V_2 is of normal amplitude, rectified potential sufficient to insure the blocking of BL.

I claim:

1. In low frequency carrier telegraph receiving apparatus, an incoming line, a demodulator having principal input terminals and control terminals and adapted to receive modulated alternating current signals and deliver corresponding direct current signals, a telegraph receiving device connected to the output of said demodulator, a principal band pass filter adapted to pass a restricted band of signal modulated carrier frequencies and having its input connected to said line, a principal amplifier connected between the output of said principal band pass filter and the input of said demodulator, an auxiliary modulator having principal input terminals connected to the output of said principal band pass filter and further having control terminals, a direct connection between the control terminals of said auxiliary modulator and the direct current output of said demodulator, an auxiliary narrow band pass filter having its input connected to the output of said auxiliary modulator, an auxiliary amplifier having its input connected to the output of said auxiliary filter and having its output connected to control terminals of said demodulator, a blocking unit having an input connection and a control connection and an output connection, said input connection being connected to the output of said principal filter, said blocking unit being adapted in the absence of energization of its control connection to pass signals with negligible attenuation, and when its control connection is energized to substantially attenuate signals, and a rectifier connected between the output of said auxiliary amplifier and said control connection for applying blocking control energy to the control connection of said blocking unit when substantial energy is delivered by said auxiliary amplifier, and a second connection from the input of said auxiliary amplifier to the output of said blocking unit, whereby the identical frequencies of the alternating currents applied at the input terminals and control terminals of said demodulator produce a signal varying current delivered from its output terminals, and additional signal input to the input of said auxiliary amplifier and to the control terminals of said demodulator is applied when said blocking unit is not blocked, and the phase of the first impulse of the reconstituting carrier frequency applied at the receiver is identical with the phase of the first signal impulse received.

2. Apparatus as recited in claim 1, and a transformer interposed in the input connections of said auxiliary amplifier, said transformer having two primary windings and one secondary winding, said secondary winding being connected to the input of said auxiliary amplifier, one of said primary windings being connected to said auxiliary filter and the other of said primary windings being connected to the output of said blocking unit.

3. In low-frequency carrier telegraph receiving apparatus, an incoming line, a channel separating filter having its input connected to said line, a demodulator having input connections and control connections and output connections, a principal amplifier having its input connected to the output of said channel separating filter and having its output connected to the input connections of said demodulator, a telegraph receiving device connected to the output connections of said demodulator, an auxiliary modulator having input terminals and control terminals and output terminals, the input terminals of said auxiliary modulator being connected to the output of said channel separating filter, the direct current output connections of said demodulator being connected to the control terminals of said auxiliary modulator, an auxiliary band pass filter having its input connected to the output terminals of said auxiliary modulator, an auxiliary amplifier having its input terminals connected to the output of said auxiliary filter and its output terminals connected to the control connections of said demodulator, a blocking unit having input terminals and output terminals and control terminals and adapted to pass signals with negligible attenuation when its control terminals are not energized and to substantially attenuate signals when its control terminals are energized, rectifier means having its alternating current input connected to the output of said auxiliary amplifier and its output connected to the control terminals of said blocking unit, the input terminals of said blocking unit being connected to the output of said channel separating filter, and coupling means adapted and connected for delivering the output from the output terminals of said blocking unit to the input terminals of said auxiliary amplifier.

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