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ARRANGEMENT FOR TRANSMITTING MESSAGES WITH THE AID OF LINE-DIRECTED CARRIER FREQUENCY CURRENTS

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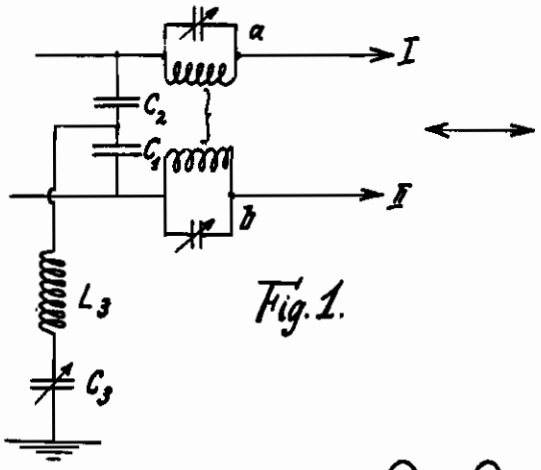

Fig. 1.

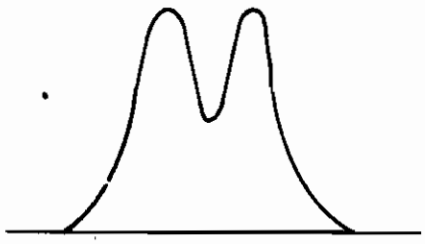

Fig. 2.

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ARRANGEMENT FOR TRANSMITTING MESSAGES WITH THE AID OF LINE-DIRECTED CARRIER FREQUENCY CURRENTS

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The present application relates to an arrangement for transmitting messages with the aid of line-directed carrier frequency currents, particularly to an arrangement of this kind for transmitting messages in a building, in adjoining buildings or in a group of buildings belonging to an enterprise.

Hitherto, it was the custom with such private telephone installations to use exclusively telephone apparatus connected by special individual lines and the simplest way of calling or communicating with different stations was by special arranged signals or by a line-finder device which, in extensive installations, had the very great disadvantage that each telephone connected to the system required a special line to each individual telephone, making it necessary to have a considerable number of lines connected to each telephone.

In order to obviate this disadvantage, an automatic telephone exchange was often provided which, however, constituted an expensive installation.

During the last few years these disadvantages were more and more obviated, especially in the United States of America, by introducing a carrier frequency system using existing private lines, including strong current lines, for transmitting carrier currents so that no special lines were required or it was sufficient to install one single wire to which the individual stations were connected.

In this case, the selection of different stations was effected with the aid of tuning devices, each connected station having a certain length of wave for receiving, and the station desiring to communicate with a certain other station transmitted a carrier frequency tuned to the station at the other end.

However, this system has various disadvantages which prevent its introduction in a large number of European countries.

In order to ensure a reliable communication between the stations, the transmitted energy must not be too small.

Consequently, the comparatively strong signals required cause considerable disturbances of adjoining installations, particularly wireless apparatus, and furthermore it is difficult to accommodate several separate installations in a building so as not to disturb each other.

For example, if the offices of one firm are in the first floor of a building and another firm has its offices in the third floor, this type of installation makes it very difficult for the offices of each firm to communicate in a satisfactory manner and to prevent the transmission of communications from the system of the one firm to that of the other, in case it is necessary to use substantially equal wave lengths in both systems, which generally will occur owing to the limited number of channels available. It is also necessary to consider that, with the known systems, the individual channels must not be too near to each other in the scale of frequencies as, for economy's sake, the individual receiving devices cannot operate with a very great selectivity.

According to the present invention, these disadvantages will be avoided by replacing the usual amplitude modulation in such line-directed carrier frequency systems by the phase or frequency modulation, known per se.

Thus, the following advantages are obtained:

As in the case of frequency or phase modulation, for obtaining a certain receiving intensity of sound with otherwise equal conditions, only about one quarter of the emitted energy is required, like with the amplitude modulation, the possibility of disturbing other devices, especially wireless apparatus in the neighbourhood, is considerably reduced, even with equally good conditions of communication between the individual stations. Apart from this, the probability of disturbing near wireless apparatus is also considerably reduced by the difference between the modulation in wireless apparatus etc. and the frequency or phase modulation, as installations, such as wireless apparatus etc., are not adapted to receive phase or frequency signals and will, therefore, respond to such signals in a very limited degree.

A further advantage of the device according to the invention is the known demodulating property of frequency modulated signals.

If a more intensive frequency modulating signal encounters a weaker frequency modulating signal, a difference in amplitude of about 1:3 or 1:4 between the two signals is sufficient to securely eliminate the weaker signal and to ensure an undisturbed reception of the more intensive signal. This means, however, that for ensuring a separation of the various individual channels in such a private telephone system, considerably shorter distances between the individual channels are sufficient in the scale of frequencies.

As in such systems it is not the question of transmitting music or the like in a first class manner, and as it is only necessary to ensure a good communication, a width of about 5000 kHz.

for a channel will generally be perfectly sufficient so that in using, for example, the comparatively long wave band of about 100 to 150 kHzs., this could contain about 10 channels, which should be sufficient for most purposes.

Though the band widths occurring in frequency modulation may be broader than the corresponding band widths in amplitude modulation, this is no special disadvantage in the present case, as, even if such outer bands should occur in a nearer or more remote neighbouring channel, they will not disturb if this neighbouring channel is used at the same time, because the above mentioned demodulating effects of a stronger signal upon a weaker signal will suppress the disturbance in a high degree.

In order that temporarily not used nearer or more remote neighbouring channels should not be disturbed by such more remote or nearer side bands, it is preferable, at least while a channel is not used, to protect receiving or call signals receiving devices connected to this channel by a certain negative liminal voltage of the tubes used therein or of a portion of same, or by other devices responding only to impulses exceeding a certain limit (for example current limiting connections, or noise eliminating devices, or capacitors constructed along the line of a copper oxide or selenium photo cell, or glow tubes, polarizing cells, biasing triodes or similar arrangements) so that such side bands will not have a detrimental effect.

In this manner, or by means of devices which will only let one side band pass through whereas the other side band is suppressed (which also may be advantageous in applying amplitude modulation in the present case), it is possible to accommodate quite a number of communication channels in a comparatively narrow frequency band.

If the entire frequency band utilized by the system amounts to only about 50 kHz. for about 10 channels, i. e. in the case of the present constructional example 100 to 150 kHz., it is also easily possible to provide an effective blocking in this comparatively narrow frequency band against these high frequency carrier currents at the points where the carrier wires, for example the electric strong current line, leave the respective building or offices.

If, in order to avoid the expenses of a highly selective arrangement and to prevent mutual disturbances of the individual channels in the older types of installations with amplitude modulation, it should be necessary to adhere to a distance of up to 20 kHz. between the individual channels, this, in the case of 10 channels, would require a total wide of about 200 kHz., and naturally an effective blocking, for example at the meter of the strong current line, would be extremely complicated.

If mere chokers are used for blocking, the great width of the band of about 200 kHz. in the case of the present constructional example, i. e. of a frequency band of 100 to 300 kHz., will be realized but very imperfectly.

However, if the width of the band is reduced to 50 kHz., a somewhat more damped single oscillation circuit or two highly coupled circuits will be sufficient to ensure a very effective blocking of such a line for the frequency used. An arrangement as shown in Fig. 1 may serve as a very effective blocking system.

In the present case, I and II are the two main lines of a strong current installation.

Two oscillation circuits *a* and *b* are, for example, tuned to a mean frequency of the frequency band used (for example with 100 to 150 kHz. about 125 kHz.

The various private telephone instruments may, for example, be connected at the side of the line installation indicated by a double arrow.

By means of the mutual inductance of the circuits *a*, *b*, and the condensers C1 and C2, a coupling is obtained (if necessary, for example if C1 and C2 require too high a coupling, the inductive coupling and the capacitive coupling may act opposite to each other) in such a way that the resonance curve of the arrangement will have a form similar to that shown in Fig. 2, the width being so as to approximately correspond to that of the total band.

The series resonance circuit C3, L3 may also be assumed to be tuned to the mean frequency of about 125 kHz.

Such a simple and cheap arrangement is in a position to very effectively suppress the comparatively narrow frequency band of a width of 50 kHz. and also to suppress disturbances of a neighbouring similar carrier frequency system as well as of neighbouring wireless apparatus.

The conditions will be still more favourable if higher frequencies are used, for example between 300 and 600 kHz.

Although the arrangement according to the invention, as shown in Figs. 1 and 2, is particularly suitable for the carrier frequency system described above, its application to amplitude modulated systems, especially with only one side band, shall not be excluded.

The effectiveness of the arrangement according to the invention may also be assisted by using, especially at the receiving end, electro-mechanical resonators as resonance bodies.

With the frequencies mentioned in the present constructional examples of about 100 to 150 kHz, it is possible to use electro-mechanically excited oscillators of steel or the like (either by pure attraction between an armature and a high frequency magnet or by electro-stricture resonators) in which, with a certain amount of feed back via a tube, the sensitivity may be considerably increased.

In case it is necessary, artificial damping should be applied in order that the speaking frequency band picked up is not too narrow.

By means of compensating devices, known per se, which will be mentioned below, the cutting of the side bands may be partly compensated in an effective manner.

Instead of the usual magnetic resonators it is possible to use such of non-magnetic material, such as glass, quartz, ceramic material or the like, if they are provided with magnetically or electrostatically effective parts so that the high frequency magnetic action of a coil may exert a mechanical effect upon them or so that the electro-static effects of a condenser may be transmitted to them by electro-statical mechanical attraction.

As resonators, it is also possible to use piezo-electric crystals or other bodies in a manner known per se.

Apart from quartz, tourmaline, etc., Seignette salt is also suitable for this purpose.

In this case, the mechanical motion of the resonator, i. e. either an oscillating magnetic or a magnetic-stricture body, or a piezo-electric body or the like, may directly serve for sound production.

For this purpose, the respective body, i. e. either one of the first mentioned magnetically effective bodies or, for example, a Seignette salt body, may be connected in a suitable manner, known per se, to a loudspeaker diaphragm or the like.

With a suitable arrangement, it is also possible that the amplitude variations of the oscillating crystal or other oscillating body are transmitted to the loudspeaker or other telephone diaphragm and are there heard as sounds.

The coupling between the oscillating material, i. e. for example the Seignette salt crystal and the loudspeaker diaphragm, may be constructed so as to act like a mechanical low pass filter and, therefore, not to transmit the high frequency oscillations in a considerable degree to the diaphragm, whereas the low frequency amplitude variations, which are within the range of hearing, reach the diaphragm and cause it to resonate.

By a suitable arrangement of the loudspeaker resonances so as to prefer high frequencies, which, if necessary, may also be assisted by electric tuning to high sound frequencies, and by corresponding high frequency arrangements, known per se, (preference of high frequencies being also obtained by using screen grid tubes and pentodes and the like for sound amplification), it is possible to prevent cutting of the side bands by too high a selectivity of the mechanical resonators.

If a preliminary amplification is used, which is practically aperiodic, letting at least the received frequency band pass practically uniformly, it is possible that, if using an electro-mechanic resonator, i. e. for example a Seignette salt crystal, it may at the same time serve as tuning instrument of the receiving device and also as demodulating device for the frequency modulation and as driving part of the reproduction instrument, (for example the loudspeaker).

If, by means of a speaking or hearing switch, it is intended to speak and hear alternately, the same electro-mechanical instrument may also serve as microphone, for example so that, by means of an ordinary or an electro-mechanically fed back tube oscillating device, the respective electro-mechanical resonator is kept oscillating, the speaking oscillations touching the diaphragm, causing varied mechanical stresses in the respective resonator, such as a Seignette salt crystal, whose natural oscillation is varied, thereby modulating the frequency of the emitted high frequency oscillations or at least of their position of phase.

If it is desired to use a mere phase modulation instead of a frequency modulation, it will be advisable, in the present case, to follow the instructions given in the German Letters Patent No. 670,306 of the applicant, in which case the total frequency band required for a certain number of channels may be considerably reduced.

The synchronizing frequency required or at least advisable in this case may lie in any free band and may be entirely different from the band comprised by the individual communicating channels. The highest possible harmonic of the current in the strong current line may, for example, serve as synchronizing frequency.

If a loudspeaker, independent of the electric resonator, is used, it is advisable, as mentioned above, to have the loudspeaker tuned as high as possible for compensating side band losses.

For this purpose, a loudspeaker according to German Letters Patent No. 638,181 (Kramolin and Masché) has proved to be suitable, because electro-static loudspeakers very much favour high frequencies, and if they are excited by an accordingly connected pentode as loudspeaker tube, they will very considerably favour high frequencies.

If the modulation is not effected as mentioned above by direct acoustical influence, but if either a separate microphone is used for speaking or if a constructional part, such as a Seignette salt crystal acting as electro-mechanical oscillator in receiving connection, is used in transmitting merely as electro-static microphone, or if a constructional part operating in listening position serves as electro-dynamical loudspeaker in transmitting, a special constructional part is required for effecting a frequency or phase modulation.

Such a constructional part may be premagnetizable ferro-magnetic cores, altering the self-inductance or mutual inductance of high frequency coils which co-operate with the premagnetizable ferro-magnetic core.

Devices of this kind are, for example, described in the British Letters Patent Nos. 449,240, 451,097 of the undersigned.

The premagnetizing windings of such a premagnetizable iron core may be used for frequency or phase modulation as well as for tuning to different lengths of communication waves by providing, for example, a premagnetizing current selectively variable by different push button switches or the like, but being fixed while communicating with another station, the premagnetizing current effecting the tuning to a certain communication channel, whereas, apart from these operating but fixed current values, adjustable by a push button and corresponding to different communication channels, there are superposed in a special exciting coil or in the same exciting coil other suitably weaker varying currents, originating either directly or after being amplified from a microphone and, therefore causing frequency or phase variations in tune with the speaking oscillations to be transmitted.

Instead of such magnetic influencing devices it is also possible to use various electro-static influencing devices, for example as described in the British Letters Patent Nos. 451,098 and 501,238 for modulating as well as for tuning purposes.

The tuning and modulating variations by varying the values of a direct current or by other devices operatable from a distance have the further considerable advantage that the casing containing the amplification tube need not be placed on writing tables in offices, where they take up too much room owing to their comparatively large dimensions and also because they develop heat, but they may be arranged anywhere near the speaking apparatus on the wall or beneath a table so that only the actual speaking apparatus and a comparatively small casing containing the operating buttons and the like are placed on the table of the operator.

With instruments as those described above, which effect the tuning by varying the current value of a tuning current (for example a premagnetizing current), but also in cases where such devices are used for phase or frequency modulation, it is very desirable that the voltages or currents used should remain constant at least as far as they influence the tuning elements.

For this purpose it is advisable to provide stabilizing devices.

These stabilizing devices may, in a manner known per se, consist of combinations of resistances with more or less positive or negative temperature coefficients or of combinations of resistances with negative and positive temperature coefficients, or there may be used glow tubes or tubes with saturation characteristic for this purpose, or devices according to British Letters Patent No. 449,049 (Schottky), or also stray or saturation transformers and chokers of the type of the known voltage regulator by Siemens.

However, in most cases a device described by the applicant at another occasion is the most suitable for this purpose, owing to its simplicity and cheapness, in which the respective modulating or tuning arrangement is supplied with the anode current of a tube with a very low magnification factor.

For this purpose, screen grids or other multiple grid tubes are suitable, whose positive grid biases, i. e. especially the screen grid voltages of a glow tube or any other stabilizing device, is tapped by connecting between the anode voltage lead of a series connection of a resistance, having no considerable temperature coefficient, and a glow tube, the latter being connected with respect to said screen grid tube or pentode at the side of the cathode and the screen grid lying at the connecting point of the resistance and the glow tube.

Such an arrangement also has the further advantage that occasional voltage impulses in the line will not cause a disturbing noise. This effect may be further increased if the heating voltage of the tubes is at the same time reduced a little so that only when a speaking switch is operated, such as by taking off a receiver or microphone from a hook or stand, the full anode or heating current will automatically become effective.

Apart from the advantages just mentioned, such a method has the further advantage that, in the state of repose, less heat is developed, the consumption of energy is reduced and the life of the tubes is lengthened.

But all the same, it must be seen to that the call signal arrives well.

In order to ensure this, it is advisable, especially in the last mentoned case, to connect, by an automatic switching operation to the loudspeaker circuit and to any preliminary circuits, tuning elements in preliminary stages of a reduction of the absorption of energy by the tubes, so that there will be in the loudspeaker circuit and in any such preliminary circuits an acoustic as well as (in the respective circuits) a highly frequent frequency characteristic, ensuring that, also with reduced absorption of energy by the tubes, such a call signal will arrive in a satisfactory manner.

For example, the tube acting as high frequency generator tube, when speaking, may be connected and arranged in the state of repose in such a way that it will seize to oscillate owing to the reduction of the energy supplied, but will then constitute a fed back and, therefore, highly sensitive receiving instrument tuned to an arriving signal of the correct frequency. This feed back or tuning may be of high or low frequency according to circumstances. One tube may also be fed back at high frequency (but suitably not oscillating) adjusted to a receiving signal, whereas one tube, suitably located behind the demodulator and fed back as well as tuned at low frequency but not oscillating, may be prepared to receive the call signal arriving with the correct frequency.

The applicant desires a protection for each of the constructional examples described or mentioned above as well as of any combination thereof.

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