

The principal subject-matter of the present invention is a device and a process for transmitting or storing information optimising the use of the pass-band.

For many years, efforts have been made to transmit higher and higher information rates.

For example, for information transmissions by radio, the use of amplitude modulation and frequency modulation leads to the use of higher and higher carrier frequencies. Phase-modulation information transmission enables the rate to be increased substantially. However, this type of transmission encounters two problems which, in the known type of device, limit the performance to below that of amplitude modulation or frequency modulation devices.

On the one hand, to be able to decode the phase-modulation coded information, at reception, it is essential to have access to a stable phase reference. Thus, it is essential to obtain perfect synchronisation of the clocks at transmission and reception. For a given frequency of the carrier wave, the information rates that can be transmitted depend on the stability of the clocks and on the precision of the phase comparators.

On the other hand, the performance of phase-modulation data transmission devices is limited by multiple echoes. In fact, when using coherent waves, multiple echoes are likely to interfere with the direct signal and disturb the reception.

Information transmission devices are known from the following documents: IEEE Transactions on Communications - Part I, volume COM-28, no 9, September 1980, IEEE, (New York, US), D.M. Grieco: "The application of charge-coupled devices to spread-spectrum systems", pages 1693-1705, US-A-4 178 549, Ericsson Review, volume 58, no. 3, 1981, (Stockholm, SE), E. Lundblad: "Contact RL400 - a new radio relay equipment", pages 128-133, Telecommunications & Radio Engineering, volume 36/37, no. 9 September 1982

(Silver Spring, Maryland, US), S.S. Kogan: "The use of the statistical properties of a digital signal in digital television systems", pages 11-18, Proceedings of IEEE, volume 68, no. 3, March 1980, IEEE, (New York, US), G.L. Turin: "Introduction to spread-spectrum antimultipath techniques and their application to urban digital radio", pages 328-353, but none of them relates to transmission at very high phase-coded information rates, or provides a solution for perfect synchronisation between transmitter and receiver clocks.

The device which is the subject-matter of the present invention enables, whilst using codes, for example pseudo-random codes, in phase modulation, the signal-to-noise ratio to be increased by pulse compression and/or synchronisation of the transmitter and receiver clocks to be obtained. Advantageously, intermittent synchronisation of the clock is obtained by convolution and/or correlation of the signal received with a pseudo-random code, at reception. Synchronisation is improved by using long-length code.

In a variant of the device according to the invention, regular codes, such as for example 0, 1, 0, 1, 0, 1, 0, 1, ... are used for the convolution.

The use of a pseudo-random code for synchronising the receiver clock makes it possible to ensure the confidentiality of transmissions made. It is thus possible to make transmissions which can only be received by the receiver equipped with the appropriate pseudo-random code generator. Thus, it is possible, in particular, to make pay-as-you-view television broadcasts.

The multiple echoes are advantageously eliminated by computation.

On the other hand, the performance of the device according to the present invention is further increased by adopting modulation by time elapsed measurements before a transition, for example within fixed duration time periods.

The present invention is not limited to data transmission. It also relates to data storage on a magnetic medium, for example. The use of phase modulation or modulation where the time elapsed before a transition is measured within fixed duration time periods enables the storage density to be increased and the same type of modulation to be obtained throughout the sequence: transmission-reception-recording.

The principal subject-matter of the invention is a phase-modulation information transmission process using a transmitter and a receiver, said transmitter and said receiver comprising a clock, characterised in that said process comprises the following stages:

- modulation of information which is phase-coded by a code, at transmission;
- convolution and/or correlation of the signal received with said code, at reception;
- synchronisation of the receiver clock with a peak obtained by convolution and/or by correlation of the signal received by said code.

The subject-matter of the invention is also a transmission process characterised in that said process comprises the following stages:

- modulation of information which is phase-coded by a code, at transmission;
- convolution and/or correlation of the signal received with said code, at reception;
- synchronisation of the receiver clock with a peak obtained by convolution and/or by correlation of the signal received by said code.

The subject-matter of the invention is also a transmission process, characterised in that said process is a transmission process for television broadcasts.

The subject-matter of the invention is also a process, characterised in that said process makes it possible to transmit the information required to produce a medium-definition television picture as well as additional information which, after processing, is capable of enhancing picture quality.

The subject-matter of the invention is also a process, characterised in that said process is an alphanumeric data transmission process.

The subject-matter of the invention is also a process, characterised in that

The subject-matter of the invention is also a process of recording information, characterised in that a code is recorded which, when it is read, is capable, by convolution and/or correlation, of enabling a clock to be synchronised with a recording clock, when it is read.

The subject-matter of the invention is also a recording process, characterised in that the value of the signal at instants determined by the reading clock are a function of the information recorded.

The subject-matter of the invention is also a recording process, characterised in that said recording process is a magnetic recording process.

The subject-matter of the invention is also modulation of an electric signal, characterised in that said signal comprises first transitions at instants occurring at regular intervals and second transitions, the instant at which said second transitions occur depending on the information to be transmitted.

The subject-matter of the invention is also modulation, characterised in that amplitude modulation is superimposed on said

modulation without the attenuation brought about by said amplitude modulation preventing reception of the transitions.

The subject-matter of the invention is also a modulated electromagnetic radiation transmitter comprising an aerial, an amplifier, a source of signals to be transmitted, a phase-coding device and a clock, characterised in that it comprises a pseudo-random code-generating device connected to the clock and to amplitude modulation means to amplitude-modulate the phase-modulated signals with the aid of said pseudo-random code.

The subject-matter of the invention is also a transmitter, characterised in that it comprises a control centre making it possible to modify and/or to distribute the information to be transmitted between a plurality of transmission channels.

The subject-matter of the invention is also a transmitter, characterised in that said transmitter is a transmitter of television broadcasts.

The subject-matter of the invention is also a transmitter, characterised in that said transmitter is a transmitter of radio-phonetic broadcasts.

The subject-matter of the invention is also a data transmission device comprising a transmitter assembly comprising an aerial, an amplifier and a reception assembly comprising an aerial, and an amplifier, characterised in that the transmission assembly comprises a code generation device and a device for coding the signal to be transmitted; the reception assembly comprising a code generator and devices for correlating and/or convoluting the signal received by the code generated by said code generator.

The subject-matter of the invention is an electromagnetic wave receiver cooperating with the transmitter defined above and comprising an aerial, an amplifier, a phase demodulator, a local oscillator and a clock connected to the local oscillator and the

demodulator, characterised in that it comprises a pseudo-random code generator connected to devices effecting the correlation and/or convolution of the synchronising signal obtained by amplitude demodulation of the signal received with the code generated by said code generator, these devices being linked to the amplifier and the clock in order to synchronise the clock, which is itself linked to the phase demodulator in order to synchronise the latter.

The subject-matter of the invention is a receiver, characterised in that said receiver is a receiver of television broadcasts.

The subject-matter of the invention is also a receiver, characterised in that it comprises a video random access memory and an address processor which, in said video random access memory, is capable of replacing information found there with new transmitted information.

The subject-matter of the invention is also a receiver, characterised in that it comprises a computer and a video random access memory capable of storing at least one image, the computer being capable of modifying all or part of the image stored in the video random access memory according to the information received.

The subject-matter of the invention is also a receiver, characterised in that it comprises a device which, by means of computation, makes it possible to eliminate multiple echoes by subtracting them from the signal or by delaying them so as to put them in modulo 2π phase with the direct signal.

The subject-matter of the invention is also a receiver, characterised in that it is capable of eliminating multiple echoes by resolving the system:

$$\begin{aligned} Y_n &= a_0 S_0 + a_1 S_1 + a_2 S_2 + \dots + a_n S_n \\ Y_{n+1} &= a_0 S_1 + a_1 S_2 + a_2 S_3 + \dots + a_n S_{n+1} \\ Y_{n+2} &= a_0 S_2 + a_1 S_3 + a_2 S_4 + \dots + a_n S_{n+2} \end{aligned}$$

$$Y_{n+3} = a_0 S_3 + a_1 S_4 + a_2 S_5 + \dots + a_n S_{n+3}$$

$$Y_{n+i} = a_0 S_i + a_1 S_{i+1} + a_2 S_{i+2} + \dots + a_n S_{n+i}$$

$$Y_{n+p} = a_0 S_p + a_1 S_{p+1} + \dots + a_n S_{p+n}$$

where a_1 is the complex amplitude of the first reflected signal, a_2 of the second reflected signal, a_3 of the third reflected signal, a_i of the i -th reflected signal, a_n is the amplitude of the direct signal, Y_{n+i} being the signal received at the instant $n+i$.

The subject-matter of the invention is also a receiver, characterised in that the device capable of effecting convolution of the signal received by a code comprising a charge-transfer device, of which some cells, corresponding to the binary code used, are connected to an output.

The subject-matter of the invention is also a receiver, characterised in that it comprises a frequency reduction device.

The subject-matter of the invention is also a control centre, characterised in that it is capable of distributing information to be transmitted between a plurality of transmission channels.

The subject-matter of the invention is also a control centre, characterised in that said control centre is digital.

A better understanding of the invention will be gained from the following description and the attached figures, given as non-exhaustive examples, of which:

- Figure 1 is a diagram illustrating the phase modulation principle;
- Figure 2 is a diagram illustrating the phase modulation and amplitude modulation principle;
- Figure 3 is a diagram of a first embodiment of a device for television broadcasts according to the invention;

- Figure 4 is a diagram of a second embodiment of a device for television broadcasts according to the invention;
- Figure 5 is a diagram of a third embodiment of a device for television broadcasts according to the invention;
- Figure 6 is a diagram of a first embodiment of a television receiver according to the invention;
- Figure 7 is a diagram of a second embodiment of a television receiver according to the invention;
- Figure 8 is a diagram of a third embodiment of a television receiver according to the invention;
- Figure 9 is a diagram of an embodiment of a transmitter for radiophonic broadcasts according to the invention;
- Figure 10 is a diagram of an embodiment of a radiophonic receiver according to the invention;
- Figure 11 is an embodiment of a data transmission device according to the invention;
- Figure 12 is a diagram of a control centre used in the device according to the invention;
- Figure 13 is a timing diagram of modulation according to the invention;
- Figure 14 is a timing diagram of modulation according to the invention;
- Figure 15 is a timing diagram of modulation according to the invention;
- Figure 16 is a diagram of an oscillator capable of being used in the device according to the invention;
- Figure 17 is a diagram of a first embodiment of a phase coder capable of being used in the device according to the invention;
- Figure 18 is a diagram of a second embodiment of a phase coder capable of being used in the device according to the invention;
- Figure 19 is a diagram of a first embodiment of a phase demodulator capable of being used in the device according to the invention;
- Figure 20 is a diagram of a second embodiment of a phase demodulator according to the invention;

- Figure 21 is a diagram of an embodiment of a recorder according to the present invention.

In Figures 1 to 21, the same reference numerals are used to designate the same elements.

Figure 1 shows a diagram illustrating the phase modulation principle. The circle 10 is a trigonometrical circle.

In digital transmission by phase modulation, the value of the phase can take a finite number of discrete values between 0 and 2π inclusive. These discrete values are represented by points 1 on the trigonometrical circle 10. The number of points 1 on a trigonometrical circle 10 depends on the precision with which the transmitter and receiver clocks are synchronised and on the S/N ratio at reception. The better the synchronisation, the greater the possibility of detecting distinct points 1, and consequently the higher the information rate transmitted. In the example illustrated in Figure 1, only sixteen points 1 are represented. Naturally, a greater number of points 1 can be used. For example, current technology enables points 1 which are an angle of 0.1 degree apart to be detected. Advantageously, the points 1 are evenly distributed over the trigonometrical circle 10.

The phase can take any of the values belonging to the interval 0.2π in the case of analogue transmissions by phase modulation.

Phase modulation makes it possible to work with constant amplitude. Advantageously, the transmission amplifiers working in the saturation state, for example class C, enables the efficiency of transmitters to be optimised.

Figure 2 shows a diagram illustrating simultaneous phase and amplitude modulation. The diagram in Figure 2 illustrates the possible phases and amplitudes of the signal 11 transmitted. So as not to lose phase information, the signal amplitude must be

between two circles 10 and 12 inclusive, circle 10 corresponding to the maximum amplitude capable of being transmitted, circle 12 corresponding to the minimum amplitude enabling a phase measurement to be taken.

Figure 3 shows a device enabling television broadcasts to be made. Said device comprises, connected in series, a video signal source, for example a television camera 7, an analogue-to-digital converter 6, a phase-coding device 2, an amplifier 3 and a transmission aerial 4. A high-precision clock 5 is linked to the analogue-to-digital converter 6, to the phase-coding device 2 and to a pseudo-random code generator 13. The pseudo-random code generator device 13 is linked to the phase-coding device 2 and/or to the amplifier 3 input.

Advantageously, a control centre 8 enables the images to be transmitted to be selected, mixed or modified. The control centre 8 enables the possibilities of the device according to the present invention to be used, particularly the fact that it is possible to separate the physical transmission channel from the data transmitted. Thus, it is, for example, possible to transmit television images, sound, alphanumeric data as well as machine control signals on a single channel. The control centre 8 enables the data to be transmitted to be processed, mixed and distributed between various channels. In the example illustrated in Figure 3, the control centre 8 is a digital control centre. It is therefore located between the output of the analogue-to-digital converter 6 and the input of the phase-coding device 2. The control centre 8 has inputs enabling it to receive video images from other sources, such as for example other television cameras or video recorders (not shown).

Advantageously, the control centre 8 makes it possible to form a plurality of channels transmitted simultaneously on a plurality of carrier and/or time-division multiplex waves. Thus it is possible not to limit transmissions to television images but thus to transmit digitised data or sound, for example.

In a variant using an analogue control centre 8, the control centre is located between the camera 7 and the input of the analogue-to-digital converter 6.

The television camera 7 enables a video image to be obtained. The video image is digitised by the analogue-to-digital converter 6 synchronised by the clock 5. The control centre 8 enables modifications of the digitised image deemed to be necessary to be made. The phase-coding device 2 converts the digital value of the image to a value of the signal phase. For example, if the video signal has been digitised to four bits (which corresponds to sixteen levels) the value "4" corresponds to a phase lag of $\pi/2$. The value of four bits was chosen as a non-limiting example and it must be understood that digitisation of the video signal comprising a considerably higher number of bits does not fall outside the scope of the present invention. The number of distinct phase levels is limited by the precision of the clocks, particularly the transmitter, phase detector and synchronising clocks as well as by the signal-to-noise ratio. However, it should be noted that the possibilities of remote clock synchronisation, by radio, are limited by the frequency of the carrier waves used and by the theory of relativity.

For the system to operate well, it is essential that a phase reference can be recreated, at reception. As will become apparent below, a clock is used for this purpose. However, it is essential to effect intermittent synchronisation of the transmitter and receiver clocks. The frequency of this synchronisation of the transmitter and receiver clocks depends on the precision and stability of these clocks. The transmitter clock 5, being part of a very expensive installation, is advantageously a clock of very high long-term precision, for example an atomic clock. Depending on the desired precision, the clock 5 is, for example, a rubidium or caesium clock or a caesium beam atomic clock. The choice of clock used depends, in particular, on the distances over which the transmissions are to be made.

It is advantageous to use a quartz oscillator having high short-term stability synchronised with an atomic clock having high long-term stability.

The synchronisation of a quartz clock may cause instability brought about by the dissipation of energy supplied to the oscillator in order to force it to adopt a desired value. In order to overcome said instability, a variant comprises two quartz oscillators alternately synchronised with an atomic clock. One quartz oscillator is synchronised with the atomic clock, the other quartz oscillator is used, simultaneously and until it is itself synchronised, as a reference for the transmission.

The use of two alternately synchronised quartz oscillators is not limited to the transmitter. In the receiver it is advantageous to use two quartz oscillators alternately synchronised with the transmitter clock.

Advantageously, the transmitter clock 5 and a receiver clock are synchronised by convoluting and/or correlating the signal received by a code, for example a pseudo-random one. To obtain clock synchronisation in this manner, a code must be transmitted.

In a first variant, a pseudo-random code generator 13 constantly transmits a code. The pseudo-random code generator 13 is linked to the phase-coding device 2. The pseudo-random code generated by the generator 13 is constantly superimposed on the phase coding of the image. For example, the phase-coded image is modulated by the pseudo-random code.

This modulation may be of low amplitude. At reception, the correlation of the pseudo-random code generated by a generator 13, by the same code, enables the clock synchronising signals to be extracted. The smaller the phase-coding modulation by the code generated by the pseudo-random code generator 13, the greater the need to use long codes. In so far as the coding is known and/or it is possible to obtain synchronising signals at

reception, it is also possible to effect phase demodulation corresponding to the synchronising code, in addition to phase demodulation of the image. Thus, modulation owing to the pseudo-random code does not substantially degrade the signal-to-noise ratio.

Advantageously, a unique pseudo-random code enables phase coding which increases the signal-to-noise ratio, ensures synchronisation of the clocks and thus, also, enables transmissions to be made secret.

It is advantageous to code the data to be transmitted in a manner enabling pulse compression. In addition to enhancing the signal-to-noise medium, confidentiality of the transmission is ensured because it is impossible to decode the signal without knowing the coding used.

In a second variant, the synchronising code is transmitted intermittently, for example alternating with the data to be transmitted.

Advantageously, in the case of television programme broadcasts, the pseudo-random code ensuring the synchronisation is transmitted during those intervals of time which are not used to transmit the signal, such as new lines and/or new frames.

In the case where the decoding device is a phase-coding device, the transmission amplifier 3 can work in class C, in which it is most efficient.

Where both phase coding and amplitude coding are desired in order to further increase the information rate transmitted, the transmitter 3 works in the conventional manner. Amplitude modulation can provide information to supplement that transmitted by phase modulation. For example, phase modulation transmits a video image and amplitude modulation transmits supplementary information enabling a high definition video image to be obtained.

Advantageously, the phase coding executed by the device 2 is selected so as to obtain the maximum signal-to-noise ratio.

Figure 4 shows an analogue transmission device for television broadcasts. The device comprises, connected in series, a television camera 7, a phase-coding device 2, an amplifier 3 and a transmission aerial 4. A clock 5 is connected to the phase-coding device 2 and to a pseudo-random code generator 13. The pseudo-random code generator 13 is connected to the phase-coding device 2 and/or to the input of the amplifier 3.

The phase-coding device 2 executes analogue phase modulation of the video signal received, for example, from the camera 7. The amplifier 3 is advantageously a coherent amplifier. For example, the amplifier 3 is a continuous wave amplifier. Advantageously, for the phase-amplitude modulation, the broadcasts are made on a single sideband. Thus, the transmission power is reduced and decoding is made easier.

Figure 5 shows a transmission device for television broadcasts. Said device comprises, connected in series, a television camera 7, an analogue-to-digital converter 6, a phase-coding device 2, a pulse compression device 19, an amplifier 3, an aerial 4. A clock 5 is connected in parallel to the analogue-to-digital converter 6, to the phase-coding device 2 and to a pseudo-random code generator 13. The pseudo-random code generator 13 is connected either to the phase-coding device 2 and/or to the input of the amplifier 3. The pulse compression device 19 enables the signal-to-noise ratio to be increased by appropriate phase coding of a type which is known in itself. For example, the device 19 varies the frequency as a function of time. For analogue versions of the device according to the invention, the device 19 is, for example, a surface acoustic wave (SAW) filter.

In a variant which is not shown, the pulse compression is carried out by the phase-coding device 2.

Figure 6 shows a television receiver according to the present invention. The device in Figure 6 comprises, connected in series, an aerial 4, a frequency-changing device 82, an intermediate frequency amplifier 3, a phase-demodulation device 20, digital-to-analogue converters 16, a cathode-ray tube 17 or an audiophonic amplifier 3 and a loudspeaker 18. On the other hand, a correlator 131 receiving a pseudo-random code from a pseudo-random code generator 130 is connected to the output of the intermediate frequency amplifier 3. The correlator 131 enables a clock 5 to be synchronised with the clock 5 in Figures 3 to 5, at reception. The clock 5 is linked to the phase-demodulation device 20. The frequency conversion device 82 comprises, for example, a local oscillator 81 supplying a duplexer 80. The frequency reduction is obtained by fluctuating between the signal generated by the local oscillator 81 and the signal received by the aerial 4. Advantageously, the local oscillator 81 is connected to the clock 5. Advantageously, the frequency conversion device 82 delivers to two quadrature outputs, not shown, the signal without phase shift and the signal out of phase by $\pi/2$.

Initially, the correlator 131 correlates the signal received from the amplifier 3 with the code 130. This correlation enables it to synchronise the clock 5 with the sampling frequency of the signal at transmission. Then, the correlator 131 shifts the code 130 in relation to the signal received from the amplifier 3 until a maximum correlation is obtained which gives the synchronisation of the phase modulation. In an embodiment, the clock 5 enables the phase-demodulation device 20 to be supplied with two frequencies, for example the 100 MHz frequency, enabling various values to be allocated to the phase, and the 10 MHz frequency, corresponding to the sampling frequency of the signal. In this case, the phase can obtain 21 values. In the non-exhaustive example, the 10 MHz frequency exactly corresponds to half of the video image production standards 4.2.2.

The use of an intermediate frequency clipper amplifier 3 enables the construction of the receiver to be simplified.

In a variant of the device according to the invention, the clock 5 is also capable of supplying a frequency which is twice the sampling frequency. Thus, it would be possible (to transmit and) to receive twice the information rate. The additional information being capable of being used either to (transmit and) receive a second television station link or to obtain a high-definition image. It should be noted that a single change of clock frequency makes it possible to switch from normal television to twice the number of available television station links or to high-definition television.

The phase demodulator makes a digital signal received by phase modulation correspond to digital values which, after conversion to analogue values by digital-to-analogue converters 16, enable electron guns or audiophonic amplifiers to be activated. For example, the phase demodulator 20 is connected to three first digital-to-analogue converters 16 connected to three electron guns of a colour cathode ray tube 17. A fourth digital-to-analogue converter 16 is, for example, connected to an audiophonic amplifier 3 which is itself linked to a loudspeaker 18. Thus, an image and sound corresponding to the television programme transmitted are obtained.

Figure 7 shows a variant of a television receiver according to the invention. The device in Figure 7 comprises, connected in series, an aerial 4, a frequency-changing device 82, an intermediate frequency amplifier 3, a phase-demodulation device 20, a bus 26, a random access memory 24 (RAM), analogue-to-digital converters 16, a colour cathode-ray tube 17. On the other hand, the phase-demodulation device 20 is linked via a bus 261, a digital-to-analogue converter 16, an audiophonic amplifier 3 and a loudspeaker 18. A correlator 131, on the one hand, and a convoluter 132 linked to a clock 5, on the other hand, are connected to the output of the intermediate frequency amplifier 3. A pseudo-random code generator 130 is linked to the convoluter 132 and to the correlator 131. The clock 5 is linked to the phase-demodulation device 20, to the video memory 24 and to a

counter 30. The counter 30 is linked to an address processor 22 of the video memory 24. On the other hand, the phase-demodulation device 20 is linked to the address processor 22. The address processor 22 is linked via an address bus 25 to the video random access memory 24.

The clock 5 comprises, for example, a quartz oscillator. In the variant requiring great precision enabling synchronisation of the transmitter and receiver clocks to be spaced, atomic clocks are used.

The address processor 22 combined with the counter 30 enables the generation of addresses transmitted to video memory 24 via the bus 25 enabling the phase-demodulation device 20 to write modifications of an image which has already been stored. Thus, it is possible to enhance the definition of the television. Once a video image has been stored in the memory 24, it is possible to receive essentially the information intended to modify this image as it develops as a consequence of a movement on the screen. This information on the modification of the image can relate to points of the image or to image elements comprising a plurality of points.

Figure 8 shows a particularly sophisticated device for receiving television images. This device makes it possible to receive high-definition television images as well as to carry out computations making it possible to overcome the influence of multiple echoes.

The receiver device comprises, connected in series, an aerial 4, a frequency-changing device 82, an intermediate frequency amplifier 3, a phase-demodulation device 20, a video memory 24, digital-to-analogue converters 16, amplifiers 3, a cathode ray tube 17 or loudspeakers 18. The output of the intermediate frequency amplifier 3 is connected to the convoluter 123. The convoluter 123 is connected to a clock 5. The clock 5 is connected to the phase-demodulation device 20. The phase-

demodulation device 20 is connected via a bus to an address processor 22. The address bus 25 enables a computer 23 and the address processor 22 to be linked to the video memory 24. A data bus 26 enables the demodulation device 20 and the computer 23 to be linked to the input or output of the video memory 24. The output bus 28 of the video memory 24 is linked in parallel to, for example, five digital-to-analogue converters 16 as well as to an external digital connection 29. The three first digital-to-analogue converters 16 are linked to three amplifiers 3 enabling three electron guns of a cathode-ray tube 17 to be activated. The amplifiers 3 enable the output levels of the digital-to-analogue converters to be matched to the optimum working level of the tube 17. It must be understood that the use of a monochrome cathode-ray tube 17 does not fall outside the scope of the present invention. In this case, a single digital-to-analogue converter 16 is used to obtain the image. Two digital-to-analogue converters 16 are linked via audiophonic amplifiers 3 to loudspeakers 18. The use of two separate audiophonic channels makes it possible to obtain stereophony or to obtain different texts simultaneously. This can, for example, be used to receive a television broadcast simultaneously with the sound in several languages. It must be understood that the use of a greater number of channels does not fall outside the scope of the present invention.

The bus 29 enables digital data to be received. It can be used, in particular, to make alphanumeric captions, such as sub-titles, appear on the screen, to transmit data or programs to microcomputers or to print desired information at a printer. Furthermore, the bus 29 makes it possible to receive control signals enabling, for example, remote control by radio, thus it is possible to program on a control device 301, using a keyboard 302, for example, the automatic start-up of the television receiver or a video recorder, for example, at the start of a broadcast.

The use of correlation alone in order to synchronise the receiver clock 5 with the transmitter clock enables the embodiment of the

device according to the invention to be simplified. However, it has the disadvantage of reducing the information rate capable of being transmitted.

The computer 23 enables a high-definition television to be obtained and/or multiple echoes to be eliminated. A transmission process for high-definition television images is described in French patent no. 82 11209.

The aerial 4 not only receives the direct signal transmitted by the transmitter but also the reflected signals. These signals have followed a path different to that followed by the direct signal. Thus, there is a delay in relation to the direct signal. This delay results in a phase difference. However, the reflection is not total, thus the reflected signal does not have the same amplitude as the direct signal. The total signal received at any instant is the superimposition of the direct signal and the reflected signals. Thus a signal Y_i is received at an instant t_i . $t_i - t_{i-1} = 1/f_e$, where f_e is the sampling frequency, for example 10 MHz.

At an instant Y_n , the following signal is received:

$$\begin{aligned} Y_n &= a_0 S_0 + a_1 S_1 + a_2 S_2 + \dots + a_n S_n \\ Y_{n+1} &= a_0 S_1 + a_1 S_2 + a_2 S_3 + \dots + a_n S_{n+1} \\ Y_{n+2} &= a_0 S_2 + a_1 S_3 + a_2 S_4 + \dots + a_n S_{n+2} \\ Y_{n+3} &= a_0 S_3 + a_1 S_4 + a_2 S_5 + \dots + a_n S_{n+3} \\ &\vdots \\ Y_{n+p} &= a_0 S_p + a_1 S_{p+1} + \dots + a_n S_{p+n} \end{aligned}$$

where a_1 is the complex amplitude of the first reflected signal, a_2 of the second reflected signal, a_3 of the third reflected signal, and so on. a_n is the amplitude of the direct signal. The signal can be standardised by using $a_n = 1$. We see that we obtain, at reception, a system of equations in which, after a sufficiently long period of time, it is possible to obtain more

equations than unknowns. The computers 23 eliminate the unknowns of the system. Once the coefficient of the system of equations is known, the computer 23 makes corrections in the video memory 24 by providing the delay needed to correct the influence of the reflected signals on the signal received.

Advantageously, at transmission, the signal is interrupted with blanks making it possible, at reception, to facilitate analysis of multiple echoes so as to improve their elimination.

Generalisations can be made for a continuous transmission signal $x(t)$, without the sampling frequency necessarily having to be constant.

A signal $y(t)$ is detected

$$y(t) = x(t) * h(t) \quad (1)$$

where $*$ is the convolution product and $h(t)$ the transfer function for the space between the transmitter and receiver.

In the absence of unwanted echoes:

$$h(t) = a_0 \delta(t - t_0)$$

being the Dirac function, a_0 the amplitude of the signal received and t_0 the time of arrival at the signal receiver.

In the presence of multiple echoes, the transfer function $h(t)$ becomes:

$$h(t) = \sum_i a_i \delta(t - t_i)$$

In order to overcome unwanted echoes, it is necessary to eliminate, in $h(t)$:

$$\sum_{i \neq 0} a_i \delta(t - t_i)$$

Let us consider the Fourier transformation of the equation (1):

$$Y(f) = X(f) \cdot H(f)$$

Where $Y(f)$ is the Fourier transformation of $y(t)$, $X(f)$ the Fourier transformation of $x(t)$ and $H(f)$ the Fourier transformation of $h(t)$.

Let $\rho_{yx}(\tau)$ be the intercorrelation function of y and of x :

$$\rho_{yx}(\tau) = \langle y | x \rangle_{\tau} = \int y(t) \overline{x(t+\tau)} dt$$

At reception, the coding $x(t)$ used at transmission is known.

Let $\phi_{yx}(f)$ be the Fourier transformation of $\rho_{yx}(\tau)$

$$\phi_{yx}(f) = Y(f) \cdot \overline{X(f)}$$

$$\phi_{yx}(f) = H(f) \cdot |X(f)|^2$$

$$\phi_{yx}(f) = H(f) \cdot \phi_{xx}(f)$$

therefore:

$$H(f) = \frac{\phi_{yx}(f)}{\phi_{xx}(f)}$$

$$\text{Let } G(f) = \frac{1}{H(f)}$$

and $g(t)$ be the inverse Fourier transformation of $G(f)$.

$$g(t) = TF^{-1} \left(\frac{1}{TF(h(t))} \right)$$

$g(t)$ is the transfer function of a filter which suppresses the multiple echoes.

Advantageously, the filter whose transfer function is $g(t)$ is a programmable digital filter.

Figure 9 shows an embodiment of a radiophonic transmission device according to the invention. The transmission device comprises, connected in series, a source of audiophonic signals 70, a phase device 2, an amplifier 3, and an aerial 4. The phase-coding device 2 is linked to a high-precision clock 5. On the other hand, the clock 5 is linked to a pseudo-random code generator device 13. The pseudo-random code generator device 13 is linked to the input of the amplifier 3.

In a variant, regular codes are used, such as for example:

0, 1, 0, 1, 0, 1, ...

or 0, 1/2, 0, 1, 0, 1/2, 0, 1, 0 ...

or 0, 1, 1, 0, 1, 1, 0, 1, 1, 0, 1, 1, ...

The sound transmission necessarily being continuous, there is no access, as with television, to times corresponding to the new line and/or new frame, during which it is possible, without degrading the quality, to transmit service data and in particular data enabling synchronisation of the transmitter and receiver clocks. Thus, for radiophonic broadcasts, the selected code is systematically superimposed on the phase coding of the audiophonic signal. The code-generation device 13, for example a pseudo-random one, enables the phase-coding device to modulate the phase-modulated audiophonic signal in accordance with said code. The source of the audiophonic signal 70 is, for example, a microphone, a video recorder or a control centre.

Advantageously, several independent audiophonic channels are transmitted by multiplexing, for example, enabling stereophony or quadraphony to be obtained.

However, in the device according to the invention the transmission channel is made independent of the signal transmitted.

Thus, it is also possible, in contrast, to transmit the signal, even if is monophonic, on a plurality of channels, for example on adjacent frequencies. The choice of the number of channels used depends on the information rate to be transmitted divided by the information rate capable of being transmitted by one channel.

Figure 10 shows an embodiment of a device for receiving radiophonic broadcasts according to the invention. Said device comprises, connected in series, an aerial 4, a frequency-changing device 82, an intermediate frequency amplifier 3, a phase-demodulation device 20, audiophonic amplifiers 3, loudspeakers

18. The clock 5 is connected to the frequency-changing device 82. A convoluter 132 and a correlator 131 are connected to the output of the intermediate frequency amplifier 3. The convoluter 132 and correlator 131 receive a pseudo-random code generated by a pseudo-random code generator 130. The convoluter 132 and correlator 131 are connected to a clock 5. The clock 5 is connected to the phase-demodulation device 20.

In the example illustrated in Figure 10, the receiver being stereophonic, it comprises two channels symbolised by two audio-phonic amplifiers 3 and two loudspeakers 18.

The bidirectional link between the phase demodulator 20 and the clock 5 enables the demodulation to be locked to the clock synchronisation and the clock to be synchronised according to the result of the demodulation.

The convoluter 132 has the advantage of a very simple construction and it enables a first synchronisation of the clock 5. The correlator 131 is responsible for fine synchronisation of the clock 5 enabling phase comparison of the signals received. The embodiment illustrated in Figure 10 is analogue. It must be understood that digital radiophonic receivers do not fall outside the scope of the present invention.

Figure 11 shows a data transmission device according to the invention. The device comprises a transmission assembly as well as a reception assembly.

The transmission device comprises, connected in series, a phase-coding device 2, an amplifier 3 and a transmission aerial 4. A high-precision clock 5 is connected on the one hand to the phase-coding device 2 which comprises an oscillator which generates the carrier frequency, and on the other hand to a code generator 13, for example a pseudo-random one. The pseudo-random code generator 13 is connected to the phase-coding device 2 and/or directly to the input of the amplifier 3. The phase-coding device 2

receives digital data on the line 100, for example, television broadcasts from television cameras 7, telephone lines 303 or computer data from computers 304.

The reception device comprises, connected in series, an aerial 4, a frequency-changing device 82 connected to the clock 5, an intermediate frequency amplifier 3, a phase-demodulation device 20. A correlator 131 and/or a convoluter 132 are connected in parallel to the output of the amplifier 3. On the other hand, the correlator 131 and/or the convoluter 132 are connected to a pseudo-random code generator 130. The correlator 131 and/or the convoluter 132 are connected to the input of a clock 5. The clock 5 is connected to the phase-demodulation device 20.

The phase-coding device 2 receives the information to be transmitted on the line 100. It effects the phase coding synchronised by the clock 5. The clock 5 is also responsible for synchronising the transmission of a pseudo-random code 13. The pseudo-random code generated by the generator 13 is transmitted alternately with the signal modulated by the phase-coding device 2, or it enables the signal to be transmitted to be phase-modulated.

In a variant of the device according to the invention, a part of the code is transmitted whilst the transmissions of the effective signal are stopped. This part enables an initial synchronisation of the clocks, the fine synchronisation being obtained from modulation of the signal transmitted.

The amplifier 3 amplifies the signal to be transmitted. The aerial 4 transmits the signal.

At reception, the aerial 4 detects the signal transmitted. The device 82 reduces the frequency of the signal, for example by causing the signal received to fluctuate with a local oscillator 81 connected to the clock 5. The intermediate frequency amplifier 3 amplifies the signal whose frequency has been reduced. The correlator 131 and/or the convoluter 132 respectively

correlate and/or convolute the signal received by a code generated by a pseudo-random code generator 130. The signal of the correlation of the convolution enables the receiver clock to be synchronised with the transmitter clock 5. Once the clocks are synchronised, the phase-demodulation device 20 enables a digital signal to be obtained on the line 400. Advantageously, a multiple echo elimination device is also used. This device operates in a manner similar to that used for television.

Advantageously, the transmission and/or reception device comprises a control centre 8.

Figure 12 shows an embodiment of a control centre 8 enabling the advantages of the device according to the invention to be used.

The control centre 8 comprises a plurality of input lines 183 connected to first processing units 148, a mixing and multiplexing unit 147, second processing units 151 and output lines 153.

The processing units 148 are connected to control lines 149. The mixing and multiplexing unit 147 is connected to a control line 150.

The processing units 151 are connected to lines 152.

The units 148 receive the signals to be processed on the lines 183. The processing units 148 process the signals received individually. For example, for video images, the processing units 148 are able on command to effect geometrical variations of the image or colour modifications.

The mixing and multiplexing unit 147 enables images to be transmitted to be obtained from a plurality of images by superimposing them and/or by allocating a part of the screen to each image.

Furthermore, the mixing and multiplexing unit distributes the data to be transmitted between the available transmission

channels. In the example illustrated in Figure 12, the mixing and multiplexing unit 147 is able to distribute the information to be transmitted between four physical channels. Thus, the transmission rate is no longer limited by the rate of a channel. At reception, the information is reconstituted from four channels. This device is extremely flexible. It is equally possible to distribute a video signal between, for example, four channels, and to transmit the video signal, the sound signal, service information as well as alphanumeric data on a single channel.

Advantageously, the service signals indicate the distribution of information over various channels to the receiver.

The processing units 151 enable modifications to be made to the signal before it is transmitted. The digital processing enables modifications to be made separately on, for example, the sound part and the video part of the signal.

Figure 13 shows a timing diagram illustrating a modulation capable of being used in the device according to the invention. Said modulation makes the transmissions, particularly digital transmissions, possible, each word being transmitted within a period T between instants 154 evenly distributed over time. A transition 158, for example a phase-transition of π , is made at instants 154. A second transition 155 is made within the period T . The instant at which the transition 155 takes place determines the digital value or the analogue information transmitted. In the example illustrated in Figure 13, three values are transmitted t_1 , t_2 and t_3 , corresponding to the time elapsed between the transition 158 and the transition 155.

Figure 14 shows an example of modulation enabling the pass-band required for transmissions to be limited. In this variant, the instants 154 of the transitions 158 are preceded and followed by intervals of time 157 during which a transition 155 is not permitted. Thus, the problem of having to transmit two transi-

tions 158, 155 which are too close together and whose frequency range is very wide is avoided.

For an interval of time 157 during which a transition 155 equal to $T/4$ is not permitted, the energy contained in the first harmonic is equal to 40.5% of the total energy.

Advantageously, the duration of the interval 157 is equal to $T/2$. In this case, 81.1% of the total energy is found in the first harmonic. The value $T/2$ for the interval 157 is close to the optimum value enabling the minor lobes (higher-order harmonic) to be minimised. These values were calculated for perfectly square-wave signals, that is for almost instantaneous changes from 0 to π and from π to 0.

In the example illustrated in Figure 14, two values d_1 , d_2 are transmitted, corresponding to the time separating the transition 155 from the centre 156 of the interval T . In the example illustrated, d_1 is a negative number, d_2 being positive.

Figure 15 shows an example of modulation comprising two modulations which are orthogonal, that is independent of each other. In addition to modulation similar to that illustrated in Figure 14, amplitude modulation is also used. Thus, in addition to the information transmitted by phase modulation, it is also possible to transmit information A_1 , A_2 , A_3 by amplitude modulation. However, it is essential that the amplitude transmitted is not lower than a threshold needed to measure the time t (Figure 13) or d (Figures 14 and 15). The use of amplitude modulation combined with phase modulation, for example, makes it possible to reduce the accuracy of the phase and amplitude detection for a given information rate and/or to increase the information rate capable of being transmitted.

Figure 16 shows an embodiment of a quartz oscillator capable of acting as a time base for the clocks used in the device according to the invention.

The oscillator comprises a quartz crystal 165 connected between the collectors of two transistors 168 and 169. On the other hand, the transmitters of the transistors 168 and 169 are linked to the earth 161 via resistors 173 and 174 respectively. The base of the transistor 168 is linked to the condenser 172, and to the resistors 171 and 170. The condenser 172 and the resistor 171 are linked to the earth 161. The resistors 170, 177 and 176, the self-induction coil 180 as well as a variable capacitor 167 are linked to the terminal 162. The terminal 162 is linked to the electric power supply and is set, for example, to the potential 12 V. The resistor 177 as well as a resistor 178 are linked to the base of the transistor 169. On the other hand, the resistor 178 is linked to the earth 161.

The self-induction coil 180 and the variable capacitor 167 are linked to the collector of the transistor 168. The collector of the transistor 168 is linked via a condenser 179 to the base of the transistor 169. The resistor 176 is linked to the collector of the transistor 169. The collector of the transistor 169 is linked via a condenser 175 to the output terminal 163.

The variable capacitor 167 enables the resonant frequency of the oscillator to be tuned. The variable capacitor 167 comprises for example a variable condenser or an interchangeable bank of condensers. Advantageously, the variable capacitor 167 comprises variable capacitance diodes (Varicap) facilitating control of the oscillator.

Figure 17 shows an example of a phase coder 2. The phase coder 2 comprises two duplexers 800 and 801, placed in parallel between an input 802 and an output 803.

The input 802 of the phase coder 2 is capable of receiving the carrier. The duplexer 800 is capable of mixing the signal 804 with the carrier. The duplexer 801 is capable of mixing the signal 805, identical to the signal 804 but out of phase by $\pi/2$,

with the carrier. The signals of two recombined branches are present at the output 803 of the phase coder 2.

Advantageously, for digital transmissions, the signal phase is coded with a phase noise, the standard deviation σ is equal to twice the quantification step q :

$$\sigma = 2q$$

Figure 18 shows a digital phase coder 2. The phase coder 2 comprises a counter 806 capable of being reset to 0 by a command 807. Advantageously, the counter 806 is a binary counter. For example, the decimal value 128 or 256 is followed by the value 0. The counter 806 is linked to a clock 5.

At each clock pulse, the counter 806 supplies a signal, for example a square-wave signal. Thus, if at the instant t_0 the counter 806 is forced to switch to the value 0 it will, at this instant, generate the start of a square-wave signal at its output 808. Thus, the signal phase is modified. In order to obtain phase modulation of the signal it is sufficient to act upon the control 807 for the counter 806. The modulated signal present at the output 808 of the phase-coding device 2 can be put on a carrier.

In a variant of the device according to the invention, the frequency of the clock 5 is higher than the frequency of the carrier. For example, the clock frequency is equal to 4096 times the carrier frequency, the counter 806 being a counter with a maximum value of 128. Thus, at each carrier period, a five bit number is transmitted. Thus, the phase modulation and frequency modulation limit is reached.

Figure 19 shows a phase-decoding device 20. The device 20 comprises two branches each comprising a duplexer 814 and 815 linked to an analogue-to-digital converter 812 and 811 respectively. The analogue-to-digital converters 812 and 811 are linked via a bus 813 to a device 810 enabling the phase to be calcula-

ted. The digital value of the phase is transmitted by the device 810 on a bus 816.

The duplexers 814 and 815 receive signals whose relative phase shift is equal to $\pi/2$. Thus, the duplexers 814 and 815 are capable of extracting the real and imaginary part of the signal.

The analogue-to-digital converters 812, 811 convert the sines and cosines of the signal phase into their digital values. The device 810 combines the phase angle with the pair (sine, cosine).

In a first variant of the device according to the invention, the device 810 is a computer.

Advantageously, the device 810 is a non-volatile memory. In this case, the bus 813 is an address bus of said memory, the bus 816 being a data bus.

Figure 20 shows an embodiment of a device 20 enabling the phase of various signal samples to be measured in succession.

The device 20 comprises, connected in series, an adapted filter 140, a digital sampler 142 and a phase-measuring device 192. An odd-numbered filter 141 is connected to the input of the adapted filter 140. The output of the odd-numbered filter 141 is connected to the input of a phase-detection device 191. The phase-detection device 191 controls the sampling device 142. The detection device 191 is, for example, a Schmidt trigger.

The phase-measuring device 192 is, for example, a phase comparator comparing the phase of the signal received with a reference phase.

In an analogue variant of the device according to the invention, the adapted filters 140 and the odd-numbered filters 141 are for example constructed in the form of the surface acoustic wave device.

In a second variant of the device according to the invention the adapted filters 140 and the odd-numbered filters 141 are digital filters.

In the example illustrated in Figure 20, the device according to the invention is connected to a phase-modulated wave reception device. The phase-modulated waves transmit, for example, television broadcasts, radiophonic broadcasts, control instructions or alphanumeric data. In an example illustrated in Figure 20, the reception device comprises, connected in series, a reception aerial 4, an ultra-high frequency amplifier 3, a frequency reduction device 82, an intermediate frequency amplifier 3. The frequency reduction device 82 comprises, for example, a duplexer 80 connected on the one hand to the ultra-high frequency amplifier 3 and on the other hand to a local oscillator 81.

In a simplified variant of the device according to the invention, the detection device 191 directly controls the phase-measurement device 192.

When the signal passes via 0, having passed through the odd-numbered filter 141, the detection device sends a control signal enabling the signal to be sampled. If the device 20 is implemented according to the invention, considerable care is taken to ensure that the delays induced in the branch comprising the adapted filter 140 and the sampler 142 are compensated by the delay induced in the branch comprising the odd-numbered filter 141 and the detection device 191.

Figure 21 shows an embodiment of a recorder and/or reader according to the invention. In the non-exhaustive example in Figure 21, the recorder is a magnetic tape recorder 861. It must be understood that the principle of the invention also applies to other types of recorder and/or reader such as, for example, optical or mechanical recorders and/or readers. Similarly, recorders and/or readers using magnetic media other than tape,

such as, for example, magnetic diskettes, do not fall outside the scope of the present invention.

A mechanism 860 ensures that the magnetic tape regularly passes in front of a plurality of magnetic heads 862. The example illustrated in Figure 21 is a video recorder comprising eight recording/writing heads. The erasing heads are not shown. Of course it is possible to replace each recording/reading head 862 with a pair of recording heads and reading head. Each head 862 is linked in the digital embodiment of the video recorder to a converter 6. The converters 6 are linked to a device 20 for coding/decoding the signal by the lines 153. The coding/decoding device 20 is connected to a control centre 8. The control centre 8 is linked by lines 183 to sources of signals to be recorded, such as for example microphones 70.

The control centre 8 is linked via an amplifier 3 to loudspeakers 18. The control centre 8 receives a control signal 150 enabling it to make the video recorder settings.

A clock 5 is connected on the one hand to a code generator 13 and on the other hand to the coding/decoding device 20.

At recording: the control centre 8 distributes the information to be stored between the recording tracks and effects prior processing of the signal. Advantageously, the distribution of the signal between the tracks depends on the desired recording quality and on the drive speed of the tape. The coding/decoding device 20 uses, for example, the modulation illustrated in Figure 14. The converters 6 adapt the digital signal received to amplitudes capable of being recorded on the tape 861 by the heads 862.

The code generator 13 enables a code, for example a regular code 0, 1, 0, 1, 0, 1, ..., to be recorded on the magnetic tape 861. The recording of this code enables the clock 5 to be synchronised at reading.

The recording of the code is either superimposed on the signal or intermittent at intervals adapted to suit the resynchronisation requirements of the clock 5.

At reading: the heads 862 generate an electric signal from the signal stored on tape.

Advantageously, the converters 6 form square-wave signals whose fronts correspond to the magnetic transitions on the tape 861.

The decoding device 20 supplies the digital values of the signals on the lines 153. The control centre 8 enables the effective signal to be reconstituted from various channels.

In the example illustrated in Figure 21, two audiophonic signals are reconstituted enabling a stereophonic sound to be obtained. In this case, the digital signals are converted into analogue audio signals, the digital-to-analogue converters are for example contained in the control centre 8. The analogue signals are amplified by the amplifiers 3 and converted into acoustic waves by the loudspeakers 18.

Advantageously, the recorder according to the invention comprises a memory, not shown, enabling the information gathered from the magnetic tape 861 to be stored. The memory is re-read intermittently. Thus, the variations in the drive speed of the magnetic tape are overcome.

Advantageously, the control centre 8 is capable of taking account of the magnetic coupling between the adjacent tracks (crosstalk).

It is for example possible to cause, by means of a magnetic shunt, a known magnetic coupling between the heads 862 in order to be able to eliminate it more satisfactorily by computation.

The invention applies in particular to the transmission and the recording of analogue and/or digital data by phase modulation.

The invention essentially applies to the transmission of radio-
phonic programmes, television broadcasts or digital data.



CLAIMS

1. A phase-modulation information transmission process using a transmitter and at least one receiver, said transmitter and said receiver comprising a clock (5), characterised in that said process comprises the following stages:
 - amplitude modulation of information which is phase-coded by a pseudo-random low-level, long-length, continuously transmitted code, at transmission;
 - convolution and/or correlation of the signal received with said code, at reception;
 - synchronisation of the receiver clock (5) with a peak produced by convolution or correlation of the signal received by said code.
2. A transmission process according to one of the preceding claims, characterised in that said process is a transmission process for digital television broadcasts.
3. A process according to Claim 2, characterised in that said process makes it possible to transmit the information required to produce a medium-definition television picture as well as additional information which, after processing, is capable of to enhancing picture quality.
4. A process according to one of Claims 1 to 3, characterised in that said process is an alphanumeric data transmission process.
5. A process according to Claim 1, characterised in that said process is a radiophonic sound transmission process.
6. A process according to one of the preceding claims, characterised in that the signal comprising first transitions (158) at instants (154) occurring at regular time intervals and second transitions (155) is modulated, the instant when



said second transitions (155) occur, constituting the coding of the information to be transmitted.

7. A process according to one of the preceding claims, characterised in that the amplitude of the amplitude modulation signal is such that the attenuation brought about by said amplitude modulation prevents reception of the transitions (158 and 155).
8. A modulated electromagnetic radiation transmitter comprising an aerial (4), an amplifier (3), a source of signals to be transmitted (7), a phase-coding device (2) and a clock (5), characterised in that it comprises a pseudo-random code generator device (13) linked to the clock and to amplitude modulation means (2 or 3) to amplitude modulate the phase-modulated signals with the aid of said pseudo-random code.
9. A transmitter according to Claim 8, characterised in that it comprises a control centre (8) making it possible to modify and/or distribute the information to be transmitted between a plurality of transmission channels.
10. A transmitter according to Claim 8 or 9, characterised in that said transmitter is a transmitter of television broadcasts.
11. A transmitter according to Claim 8 or 9, characterised in that said transmitter is a transmitter of radiophonic broadcasts.
12. An electromagnetic wave receiver cooperating with a transmitter according to one of Claims 8 to 11 and comprising an aerial (4), an amplifier (3), a phase demodulator (20), a local oscillator (81) and a clock (5) linked to the local oscillator and the phase demodulator, characterised in that it comprises a pseudo-random code generator (130) linked to



devices (131, 132) effecting correlation and/or convolution of the synchronising signal obtained by amplitude demodulation (3) of the signal received with the code generated by said code generator (130), these devices (131, 132) being linked to the amplifier (3) and the clock in order to synchronise the clock which is itself linked to the phase demodulator in order to synchronise the latter.

13. A receiver according to Claim 12, characterised in that said receiver is a receiver of television broadcasts.
14. A receiver according to Claim 12 or 13, characterised in that it comprises a video random access memory (24) and an address processor (22) which, in said video random access memory (24), replaces information found there by new transmitted information.
15. A receiver according to one of Claims 12 to 14, characterised in that it comprises a computer (23) and a video random access memory (24) to store at least one image, the computer being capable of modifying all or part of the image stored in the video random access memory according to the information received.
16. A receiver according to Claim 12 or 13, characterised in that it comprises a device which, by means of computation, makes it possible to eliminate multiple echoes by subtracting them from the signal or by delaying them so as to put them in modulo 2π phase with the direct signal.
17. A receiver according to Claim 16, characterised in that it comprises processors to eliminate multiple echoes by resolving the system:



$$Y_n = a_0 S_0 + a_1 S_1 + a_2 S_2 + \dots + a_n S_n$$

$$Y_{n+1} = a_0 S_1 + a_1 S_2 + a_2 S_3 + \dots + a_n S_{n+1}$$

$$Y_{n+2} = a_0 S_2 + a_1 S_3 + a_2 S_4 + \dots + a_n S_{n+2}$$

$$Y_{n+3} = a_0 S_3 + a_1 S_4 + a_2 S_5 + \dots + a_n S_{n+3}$$

.

$$Y_{n+i} = a_0 S_i + a_1 S_{i+1} + a_2 S_{i+2} + \dots + a_n S_{n+i}$$

.

$$Y_{n+p} = a_0 S_p + a_1 S_{p+1} + \dots + a_n S_{p+n}$$

where a_1 is the complex amplitude of the first reflected signal, a_2 of the second reflected signal, a_3 of the third reflected signal, a_i of the i -th reflected signal, a_n is the amplitude of the direct signal, Y_{n+i} being the signal received at the instant $n+i$.

18. A receiver according to one of Claims 12 to 17, characterised in that the device (132) effecting convolution of the signal received by a code comprises a charge-transfer device, of which some cells, corresponding to the binary code used, are linked to an output.
19. A receiver according to one of Claims 12 to 15, characterised in that it comprises a frequency reduction device (82).
20. A transmitter according to one of Claims 8 to 11, characterised in that it comprises a control centre (8) to distribute information to be transmitted between a plurality of transmission channels.
21. A transmitter according to Claim 20, characterised in that said control centre (8) is digital.
22. Data transmission device, characterised in that it comprises a transmitter according to one of Claims 7 to 12 and/or a receiver according to one of Claims 13 to 22.



23. Use of the process according to one of Claims 1 to 7 for the recording of information modulated by modulation such as phase modulation synchronised by a clock, characterised in that a code is recorded with this information and, when the information thus recorded is read, the code is read and convoluted or correlated with the information read in order to synchronise the reading clock with the recording clock.
24. Use according to Claim 23, characterised in that the code is a regular code.
25. Use according to Claim 24, characterised in that the code is of the 0, 1, 0, 1 ... type.
26. Use according to one of Claims 23 to 25, characterised in that the code is superimposed on the information recorded.
27. Use according to one of Claims 23 to 25, characterised in that the code is recorded intermittently.