

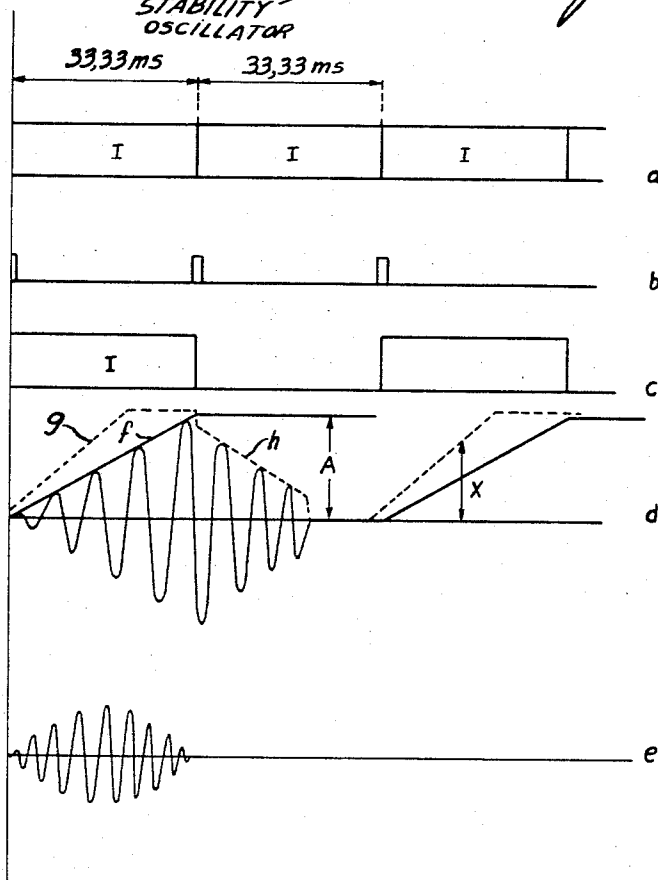
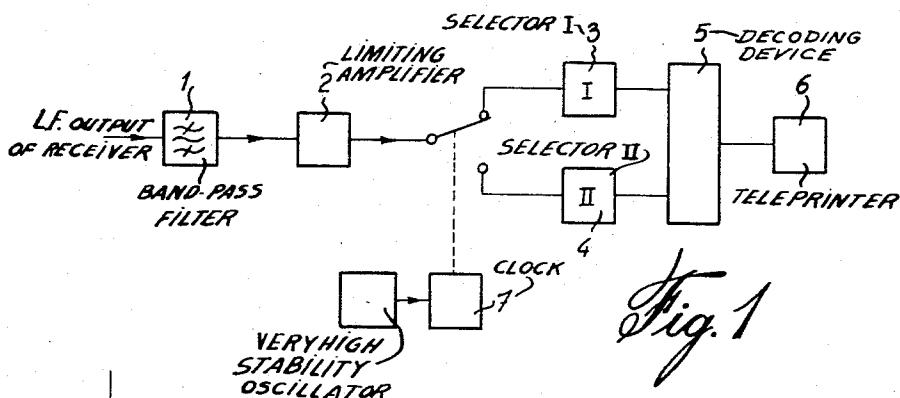
Dec. 24, 1968

JEAN-JACQUES CUVELIER
MULTIFREQUENCY TELEGRAPH RECEIVER WITH DAMPING
MEANS FOR RESONANT REED DETECTORS

3,418,428

Filed Oct. 18, 1965

3 Sheets-Sheet 1



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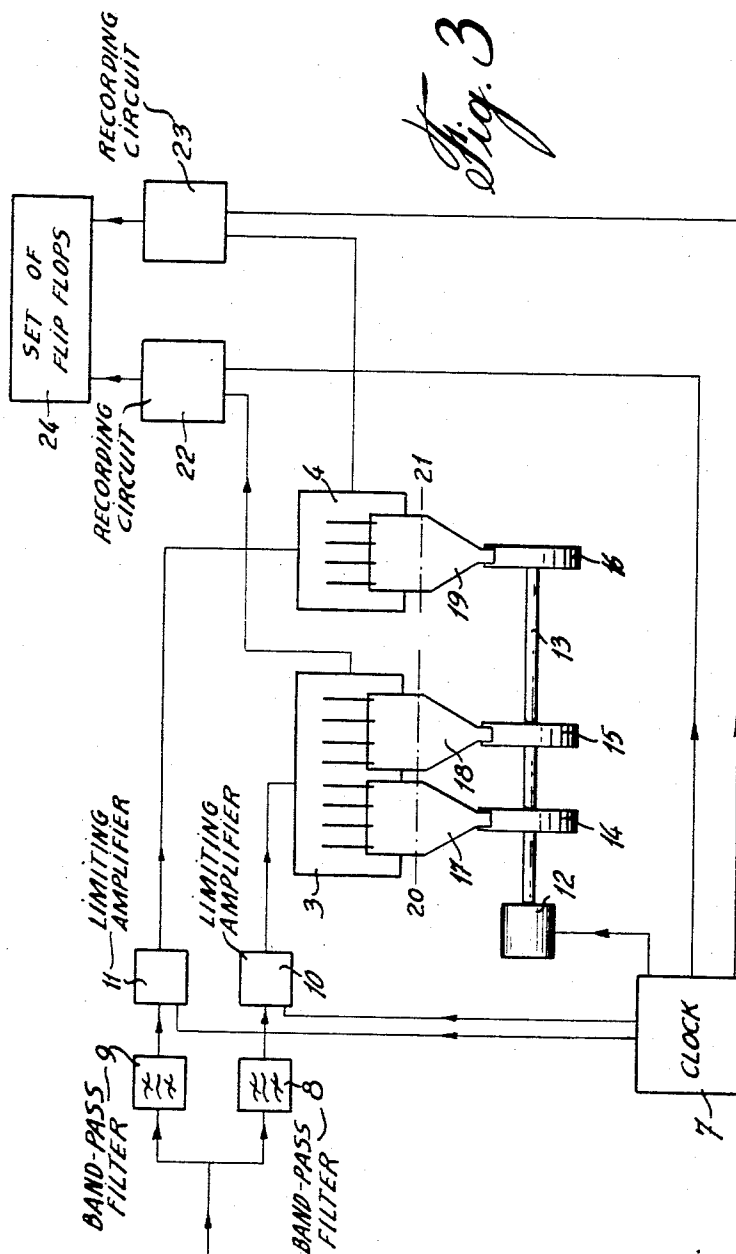
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3 Sheets-Sheet 2



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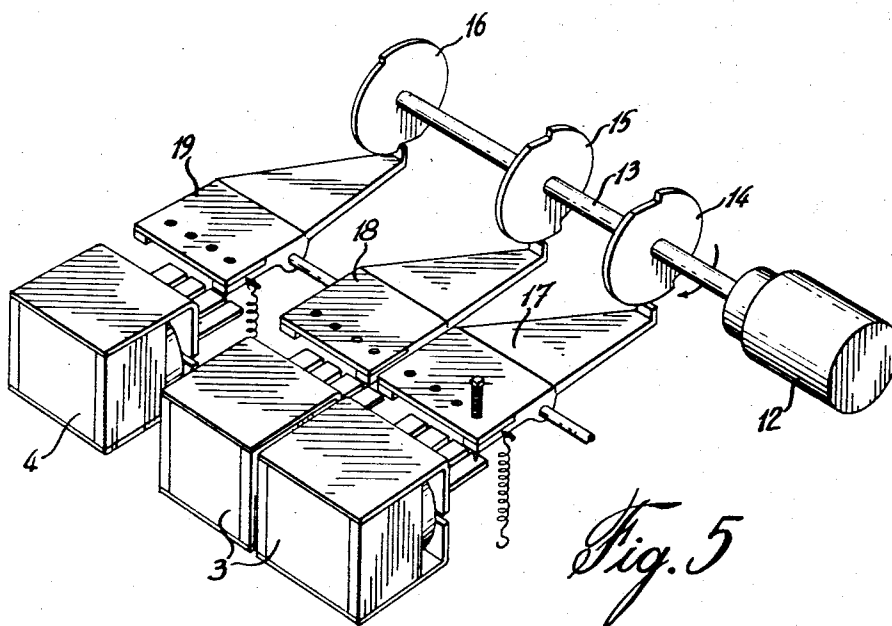
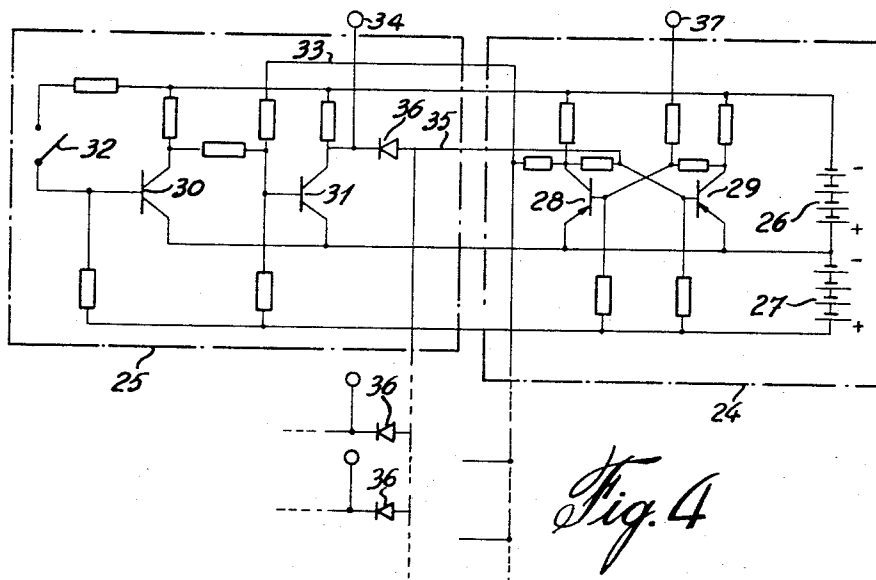
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3 Sheets-Sheet 3



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MULTIFREQUENCY TELEGRAPH RECEIVER WITH DAMPING MEANS FOR RESONANT REED DETECTORS

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654,576

7 Claims. (Cl. 178—48)

ABSTRACT OF THE DISCLOSURE

Apparatus for the synchronized transmission by teleprinter in which each sign or letter is represented by the successive transmission of two signals at different frequencies in accordance with a two-unit code having twelve frequencies distributed into two groups, corresponding to the two units, one of eight frequencies and the other of four frequencies. The spacing between adjacent frequencies in the groups has an identical value and the duration of the units is equal to the reciprocal of this spacing. The received signals act on two vibrating reed selectors corresponding to the two groups of frequencies, wherein the selectors reactive to the signals of the first and second groups are alternately switched on these signals and are equipped with a device that simultaneously moves the contacts associated with the various reeds in the direction of the latter in such a manner that the distance of these contacts from the axis of vibration of the reeds varies as a function of time, in accordance with a law so selected that, during the interval of time reserved for the unit affecting the other selector, the contacts move toward the reeds at sufficient speed to enable the vibrating reed to be touched at each vibration so as to gradually damp the vibration of the reed to zero before the end of the unit, and on reappearance of the unit affecting the selector concerned, the contacts return to their spaced position at a speed which is greater than the speed at which the reeds rise to their maximum amplitude.

The instant invention relates to transmission by teleprinters in which use is made of audio-frequency signals.

A system based upon the use of a two-unit twelve frequency code is known in which each sign or letter to be transmitted is represented by two signals transmitted successively and having different frequencies, the first one of which is part of a first group comprising eight frequencies and the second one is part of a second group comprising the four remaining frequencies. In the known teleprinters operating according to this system, there is used at the receiving end two vibrating-reed selectors the resonant frequencies of which correspond to the respective frequencies of the code, one of the selectors exciting all of the reeds corresponding to the first group of eight frequencies, the other exciting the set of reeds corresponding to the second group of four frequencies. These reeds are associated with contacts which, through appropriate electronic circuits, determine the excitation of five electromagnets controlling the selecting and printing mechanism similar to that of five-unit systems.

The vibrating reeds constitute very stable filters having a very narrow band-pass which are very closely comparable to infinite selectivity filters. It is known that if a series of infinite selectivity filters, having successive resonant frequencies differing from each other by the same variation Δf , is simultaneously excited with a frequency equal to one of these characteristic frequencies, the output signal of the filter tuned to this frequency increases indefinitely in amplitude as a function of time

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whereas, for the other filters, the amplitude varies periodically while always passing through zero at the end of a period equal to $1/\Delta f$. There exists a transmission system making use of this property, using a code having 32 different frequencies in which each sign to be transmitted is characterized by one of these frequencies. This system which necessarily requires synchronization of the receiver to the transmitter has the advantage that each signal has a duration which in principle is twice as long as in the preceding system, the speed of transmission being equal. On the other hand, it requires 32 electric filters each incorporating an amplifier to compensate for their damping and thus give them a quality factor which can be considered as infinite.

Over known systems, the system of transmission according to the invention has the advantage of a much greater simplicity. On the one hand, it makes use of the property that vibrating reeds practically act in the field of use contemplated as infinite selectivity filters and, on the other hand, takes advantage of the fact that the frequencies of the two-unit code used in the known vibrating reed teleprinters vary successively from one another by a constant value so that, provided there is synchronization and the duration of a unit is equal to the reciprocal of this variation in frequency, it is possible to obtain the most favourable conditions for the detection, particularly by bringing to zero the transient response of the filters, the frequency of which is different from that of the signal.

The transmission system according to the invention is characterized in that the selectors relating to the signals of the first and of the second group are commutated alternatively over them and each provided with a device which, under the action of a cam, simultaneously displace the contacts relating to the various reeds in the direction of the cam in such a manner that the distance of these contacts in relation to the oscillation axis of the reeds varies in time according to a law so chosen that during the interval of time which is reserved to the moment interesting the other selector, the contacts move toward the reeds at a speed sufficient for the oscillating reed to be touched in a minimum of time but relatively slowly in relation to the oscillation period thereof, then that the reed be dampened and that thereafter, at the coming of the moment relative to the interested selector, the contacts come back to their distant position at a speed greater than the maximum rise of oscillation amplitude of the reeds. The reed having touched its contact causes, by this very fact, the appearance of an output signal of an amplifier relative to the reed, which signal acts on the selection rockers of the teleprinter and determines at the same time a change in an electronic rocker common to all amplifier relative to different reeds which on the one hand locks the operating amplifier in such a way that it continues to supply an output signal and on the other hand locks all other amplifiers and this, until a signal controlled by a synchronizing clock sets the detecting assembly back to zero.

The following description and appended drawings relate to an embodiment of the invention. In the drawings:

FIGURE 1 is a block diagram illustrating the principle of the receiving apparatus;

FIGURE 2 is a set of waveforms plotted to a time base illustrating the operation of the apparatus;

FIGURE 3 is a block diagram of the receiving apparatus shown in greater detail;

FIGURE 4 is a detailed circuit diagram of part of the apparatus of FIGURE 3;

FIGURE 5 is a perspective view of the vibrating reed mechanism.

The code used for the transmission by teleprinter comprises a first group of 8 frequencies ranging from 812 to 1022 c./s. with successive differences equal to 30 c./s.

and a second group of four frequencies ranging from 1082 to 1172 c./s. with the same successive differences of c./s. Each sign to be transmitted is represented by the successive transmission of two signals having different frequencies belonging respectively to the first and to the second group, each during a period of $\frac{1}{30}$ second; the time required for the transmission of one sign is therefore of $\frac{1}{15}$ second. The units alternately relating to group I and to group II succeed one another without interruption at the rate defined above controlled at the transmission end by adequate pulses derived from a known very high stability oscillator.

The principle of the receiving device is shown diagrammatically in FIG. 1. The signals issued from the low frequency portion of the receiver pass through a band filter 1 and through a limiting amplifier 2 and are changed-over at the rate of the succession of units on two vibrating reed selectors 3 and 4 respectively tuned to the frequencies of the groups I and II of the code. This change-over which is symbolically illustrated in FIG. 1 by the action of a reversing contact may be obtained in any adequate manner for instance by providing a band filter and a limiting amplifier for each of the two groups with alternating cut-off of these two amplifiers. The change-over is in all cases controlled by a clock 7 driven by an oscillator having a very high stability similar to that used at the transmitting end. Means (not shown) are provided to bring this clock into phase with the rate of the succession of unit; once this adjustment has been carried out, in view of the extreme stability of the oscillators, the phase can be held for a long period of time and it is only sufficient to readjust it, for instance daily. The signals acting on the reeds of the selectors are subjected to a relative detection and control the selection and the printing of a teleprinter 6 through a decoding device 5 according to a process hereinafter explained in connection with FIG. 2 which illustrates, as a function of time:

At *a*: the succession of units corresponding to groups I and II.

At *b*: the pulses supplied by clock 7 producing the change-over of selectors 3 and 4.

At *c*: appearance of the signals of group I at selector 3.

At *d*: the vibrations of a reed of selector 3 excited by a signal of group I having a frequency equal to its characteristic frequency.

At *e*: the vibrations of the reed of the same selector tuned to the next higher frequency and excited by the same signal.

According to what has been said previously, the amplitude of the vibrations of the reed of selector 3 excited to its characteristic frequency increases constantly until the end of unit I then, in the absence of damping, it will remain at its peak value *A* whereas the amplitude of the vibrations of another reed of the same selector passes through zero at the end of the unit after having reached one or several peaks.

The selector is provided with a device which, under the action of a cam having an appropriate profile, causes simultaneous displacement of all the contacts associated with the various reeds in the direction of the said reeds in such a manner that the distance *x* of the said contacts in relation to the axis of vibration of the reeds varies, as a function of time, according to the law illustrated by the dotted line of FIG. 2. This law is so chosen that during the interval of time reserved for unit II which interests the other selector, the contacts close in sufficiently rapidly for the oscillating reed to be touched in a minimum of time but relatively slowly in relation to the oscillating period of the reed, so that the reed be dampened and thereafter at the reappearance of the next unit I the contacts return to their retrieved position at a speed which is greater than that of the rise in maximum oscillation amplitude of the reeds. In this manner, a very

efficient relative detection is obtained even at the weak levels.

It has been seen that the reed which is excited to a frequency equal to its resonant frequency starts to vibrate with a continuously increasing amplitude and, when the excitation ceases, if it was left to itself, it would retain substantially the amplitude *A* that it had at the time the excitation ceased considering the weak damping (FIGURE 2*d*), whereas a reed having a different resonant frequency vibrates with an amplitude passing through one or several peaks during the unit, but passing through zero at the end of the latter (FIGURE 2*e*). This property is being employed to detect the reed that is excited to its characteristic frequency and, for that purpose (see FIGURE 2*d*), during unit I, where the reed rises continuously in vibration amplitude (curve *f*), the contacts are spread according to a faster law (curve *g*) so that no contacts be touched by a reed. At the end of unit I, the reed has reached the vibration amplitude *A* and the selector to which it belongs is at rest (it is the selector corresponding to unit II that then operates). During unit II the contacts of the reed are brought closer according to a law illustrated by the curve *h*. The vibration amplitude of the reed obviously follows this curve *h* since it comes to abut the contact. The speed with which the contacts close may not be too great because, as the reed vibrates, it alternately comes closer and moves away from the contact; if the speed was very great and if, by accident, the contact would come close to the reed at the time when the latter was moving away, nothing would be detected. The speed can not be too slow as it is important that detection be made as soon as possible to avoid errors. It is obvious that, the closing-in movement of the contacts continuing until the reed practically reaches amplitude zero, it produces damping of the said reed.

Selector 4, relating to group II, obviously comprises means that are similar and operate identically.

The synchronization of the movement of the cams is controlled by a clock through any convenient means as for instance by driving them with a synchronous motor fed by an oscillator monitored by the said motor or by driving them through clutches controlled in dependency of the same clock, etc.

FIG. 3 illustrates a detailed circuit diagram of a receiving apparatus operating according to the above-described procedure. The low frequency signals of the receiver are filtered by two band-pass filters 8 and 9, for the respective frequencies of group I and group II, followed by limiting amplifiers 10 and 11 which feed selectors 3 and 4. Clock 7 sends cut-off signals lasting one moment ($\frac{1}{30}$ second) alternatively to amplifiers 11 and 10 thus allowing alternative admission of units I and II to respective selectors 3 and 4. A motor 12, synchronized by clock 7, actuates a shaft 13 carrying three cams 14, 15 and 16 of identical profile but cam 16 is offset in relation to cams 14 and 15 which are in phase. These cams act on contact-carrying parts 17, 18, 19 pivoting about axes 20 and 21 and cooperating with the reeds of selector 3 in the case of the first two parts and with the reeds of selector 4 in the case of the third part. The reeds of selector 3 are distributed into two series of four; in this manner, three identical contact-carrying parts are obtained having the same mechanical behavior. The cams are profiled and arranged in such a manner as to provide the operation described above. FIG. 5 shows them in a perspective view in association with the selectors. The relative detection obtained by the movable contact is recorded in the circuits 22 and 23; only the first contact received is recorded; all the subsequent contacts are neutralized by the circuits, an embodiment of which is illustrated in FIG. 4. These circuits finally determine the operation of the assembly of flip-flops 24 controlling the selection of the teleprinter.

Circuits 22 and 23 receive from clock 7 zero-setting

signals after operation, that illustrated in FIG. 4 and associated with selector 3, for instance, comprises a common part 24 and eight parts 25 each associated with one reed of the selector. The common part 24 comprises a supply source 26, a bias source 27 and two transistors 28 and 29 connected to form a bistable circuit. Each of the parts 25 consists of an amplifier provided with two transistors 30 and 31 the input of which is connected to the corresponding reed 32. At rest, transistor 30 becomes non-conductive, 31 conductive, 28 conductive and 29 non-conductive. If reed 32 closes its contact, the state of the transistors is changed; transistor 31 is held conductive by lead 33 to the common bistable circuit and it sends a signal through terminal 34 to the bistable circuits of the teleprinter whereas through lead 35 and diodes 36, the amplifiers associated with the other reeds become non-conductive and do not transmit any signal through their corresponding terminal 34. At the end of the unit, the common bistable circuit through terminal 37 receives a signal triggered by the clock which returns it to its initial condition and it also, through lead 33, sets the amplifier of the reed which has just operated back to zero. The detection circuit associated with the other selector is obviously made up in a similar manner.

The device above described offers the advantage that in the case of difficult conditions for wireless transmission, it is possible to simultaneously reduce in half the speed of transmission and the speed of the cam shaft of the receiving selectors; the operation of the relative detection remains unchanged: it is sufficient also to bring the excitation current of the selectors back to half of its value for reasons of mechanical stresses in the reeds.

Another advantage results from the fact that in a receiver-transmitter station, the high stability oscillator serving as a base for the synchronizing clock may also serve to drive the single side-band transmitter and receiver as well as the eventual coding and decoding devices.

It is possible to make changes to the above-described device without departing from the spirit of the present invention.

I claim:

1. In a device for synchronized transmission by teleprinter wherein each sign or letter is represented by the successive transmission of two signals having different frequencies according to a two-unit code having twelve frequencies divided into two groups corresponding to the two units, one of eight and the other of four frequencies successively spaced from one another by a constant value, the time duration of the units being equal to the reciprocal of this spacing and the signals acting at the receiving end on two reed selectors corresponding to the two groups of frequencies, said reeds capable of vibrating about a predetermined axis and each having a contact, the combination comprising:

(a) switching means whereby the selectors relating to the signals of the first and of the second group are alternately switched on said groups, and

(b) cam means for each of said selectors to simultaneously displace the contacts of the different reeds toward the reeds in such a manner that the distance between said contacts and the vibrating axis of the reeds varies as a function of time according to a law so chosen that during the interval of time reserved for the unit affecting the other selector the contacts move toward the reeds at a speed sufficient for the vibrating reed to be touched in a minimum of time but relatively slowly in relation to the vibration period thereof, so that the reed be dampened and that thereafter at the coming of the unit affecting the selector concerned contacts return to their distant position at a speed greater than the maximum rise of vibration amplitude of the reeds.

2. A combination as claimed in claim 1 wherein said teleprinter includes selection bistable circuits and further comprises an amplifier associated with each reed of a selector to send an output signal to the said teleprinter selection bistable circuits when the reed touches its contact; an electronic bistable circuit controlled by said amplifier and a synchronizing clock; said output signal to be maintained by the feedback of said electronic bistable circuit and to simultaneously block all other amplifiers until a signal emitted from said synchronizing clock and acting on said electronic bistable circuit brings the circuits back to their initial state.

3. A combination as claimed in claim 2 including a very high stability oscillator and wherein said synchronizing clock is driven by said oscillator.

4. A device according to claim 2 including means whereby the movement of said cams is synchronized by said synchronizing clock.

5. A combination as claimed in claim 3 wherein the high stability oscillator is also used to drive the transmitter of the transmitting-receiving station, to supply the signal of the single side-band receiver and to synchronize eventual coding and decoding devices.

6. A combination as claimed in claim 1 wherein the selector corresponding to the group of 8 frequencies is provided with two identical cams simultaneously acting on two contact-carrying parts similar to those of the selector of the other group and acting each on four reeds.

7. A combination as claimed in claim 1 including means to reduce by half the speed of transmission and of the cam shaft of the receiving selectors as well as the exciting currents of the latter.

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ROBERT L. GRIFFIN, *Primary Examiner*.

J. T. STRATMAN, *Assistant Examiner*.

U.S. Cl. X.R.

329—198; 331—156; 333—71; 178—88