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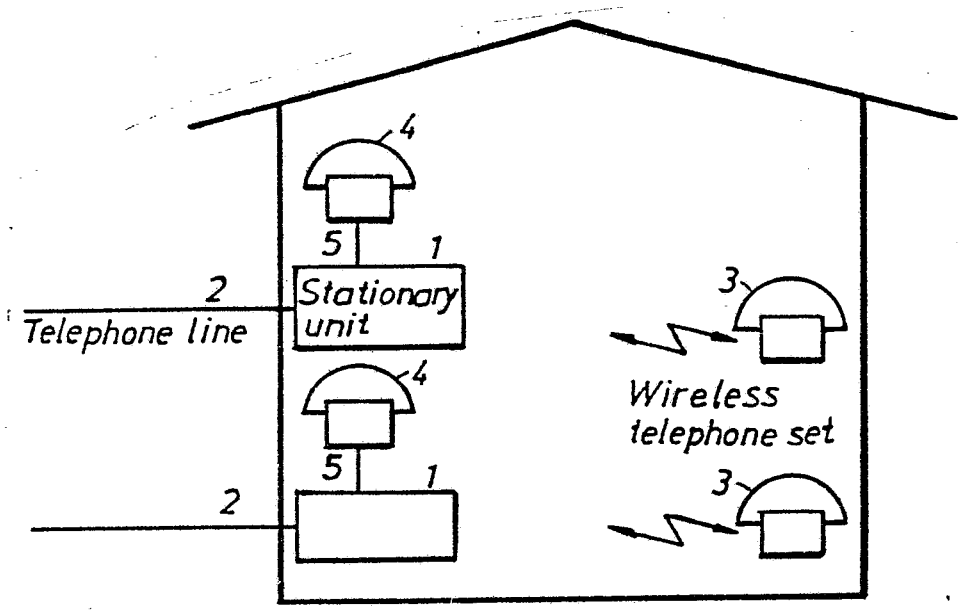

(57) Abstract

In equipment for wireless transmission of telephone calls between a stationary unit (1) connected to a telephone line (2) and a portable wireless telephone handset (3) at a short distance from the stationary unit, all the pairs of units (1, 3) have access to a plurality of common duplex radio speech channels for transmitting the calls, and a common radio signalling channel for transmitting signals concerned with establishment and disconnection of the speech channels. The radio speech channels are assigned after adaptive channel scanning in that they are listened-into before a call and a channel is selected which is unoccupied. A single speech channel is used for both transmisssion directions, which is enabled by time division and time compression. The degree of time compression is adjustable in response to whether speech signals are present for transmission or not. The equipment radio transmitters (11, 24) are adapted for either sending digital or analogue speech signals. The equipment radio receivers (12, 25) are adapted for operation according to the homodyne principle.

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EQUIPMENT FOR WIRELESS TELEPHONE TRANSMISSION

TECHNICAL FIELD

The present invention relates to equipment according to the preamble of the following independent claims.

BACKGROUND ART

There are already a number of simple portable wireless telephones available on the market. The portable telephone coacts with a stationary unit situated in its vicinity, this unit being connected to a telephone line. A radio frequency is used for transmitting speech from the stationary to the portable unit, and for transmission in the opposite direction another radio frequency is used, a conversation normally being transmitted in full duplex. An installation with such portable telephones is described in the Swedish Patent Application SE-A-8107663-0.

The availability of radio frequencies is limited, however, and many of them will be engaged when each pair of telephones is to have two radio frequencies.

DISCLOSURE OF INVENTION

In accordance with the present invention there is only one radio call channel assigned to a pair of units comprising a fixed unit and a wireless handset. Telephone calls are transmitted in both directions on this single channel. The transmission is enabled by the channel being time-divided in short, cyclically recurring time intervals. Furthermore, all the wireless handsets or radio transmitters have a time compressor device and all receivers a time expander device. The apparatus in accordance with the invention is characterized as is disclosed in the characterizing portion of the following claims.

In one embodiment of the invention the time compressor device is implemented for utilising only a small part of the divided time interval when there is no telephone signal to be sent, and a major portion of the time interval when there is a telephone signal to be sent. The available frequency space for transmission

of the telephone signals is accordingly increased, as well as voice sound quality.

In its basic implementation the apparatus is provided with a radio transmitter adapted for sending digitalized voice signals, but in a development of the invention the transmitters are adapted for sending analogue voice signals, and in this case there is decreased demand on the signal frequency range. The radio receivers in the equipment are, to advantage, adapted for operating according to the homodyne principle, the frequency of the local oscillators then mainly being the same as the carrier frequency of the radio transmitters, since each transmitter in a pair of units is to send on the same radio speech channel.

BRIEF DESCRIPTION OF DRAWINGS

An example of equipment in accordance with the invention is described in the following, with reference to the accompanying drawings, on which
Figure 1 illustrates the units in a wireless telephone system,
Figure 2 illustrates the stationary unit,
Figure 3 illustrates the radio communication section in the stationary unit,
Figure 4 illustrates the portable unit,
Figure 5 illustrates sub-units or sections in the stationary unit,
Figure 6 illustrates sub-units or sections in the portable unit and
Figure 7 is a time chart of time compression and time expansion.

BEST MODE FOR CARRYING OUT THE INVENTION

In an example of equipment having wireless telephone units, as illustrated in Figure 1, there are two sets of units, each with a stationary unit 1 connected to a telephone line 2, a wireless telephone unit 3 and a normal telephone unit 4 connected to the stationary unit 1 by a line 5. The enumerated units are preferably intended for being in the same house or office, i.e. that there is a short distance between the stationary unit 1 and the associated wireless unit 3.

In the stationary unit 1, Figure 2, there is included a line connection section 6 and a radio communication section 7, hereinafter called radio section for the sake of brevity.

The line connection section 6 contains components which are not drawn in, namely a ringing signal detector, circuits for sending numbers, control logic and adaption circuits of normal implementation for telephony purposes, and which do not need any closer description.

Seen from the line side the equipment thus functions as an ordinary telephone with side apparatus.

The radio section 7, Figure 3, contains a radio transmitter 11 and receiver 12 for speech and signalling, antenna tuning 13 and an antenna 14. The radio section also contains a channel selector 15 and logical circuits for signalling 16 and monitoring 17. A voice adaption section 18 and a current supply section 19 are also included.

The wireless telephone handset 3, Figure 4, is portable and made such that as far as using it is concerned it functions as a normal telephone handset, although differing from one in shape. In an ordinary telephone handset there are included a microphone 21, a cradle contact 22 and a number selector 23. These are supplemented in the handset 3 by a radio transmitter 24, receiver 25, antenna tuner 26 and an antenna 27, as well as a channel selector 28 and logical circuits for signalling 29 and monitoring 30, a voice adaption section 31 and a current supply section 32 with batteries being finally included.

The radio transmitters 11, 24 and receivers 12, 25 in the stationary and portable units are adapted for being switched between a plurality of duplex channels with the aid of the respective channel selector 15, 28. The channels are a signalling channel, to advantage but not necessarily common to all pairs of units, and an optional number of radio speech channels. The channel selectors are adapted for listening to each of the speech channels for determining whether it is engaged or unoccupied and for setting the transmitter on the unoccupied channel encountered first.

Equipment of the kind disclosed here is described in the patent application mentioned in the introduction.

In the exemplified inventive equipment, a radio speech channel consists of a

selected frequency band with a bandwidth suitable for transmitting a call in one direction. It is customary for the frequency bands to be selected such that channel separation is 25 kHz. As will be seen from Figures 5 and 6, for a call in full duplex to be transmitted on a single speech channel, i e that both transmitters in a pair send on the same frequency, it is thus required that the channel selectors 15 and 16 are equipped with time-controlled transmitter-receiver switches 41 and 51 in the stationary unit 1 and the wireless handset 3, respectively. The switches are adapted for changing the transmission direction of the radio transmitters 11 and 24, respectively, with such short intervals in time, of the order of magnitude 100 ms, that interruption in the call is unnoticable.

So that no part of the conversation will be lost, the radio transmitters 11 and 24 are furthermore provided with time compression means 42 and 52, respectively, adapted for storing speech signals during an interval when the respective transmitter is closed and, when the transmitter is coupled in, to send the stored speech signals during about half a time interval, thus with approximate double real time speed.

The radio receivers 12 and 25 are provided with time expansion means 43 and 53, respectively, which are adapted to store the received compressed speech signals when the receiver is switched in, and when it is closed and the transmitter is switched in, to feed out the speech signal at real time speed.

The described means enable conversation in full duplex on one radio channel, the bandwidth of which is only dimensioned for transmission in one direction. The double utilization of a channel in this way has a certain effect on the quality of the transmission, which will be discussed later on here.

The time sequence in transmission and reception is described in the time chart in Figure 7. The speech signals in the transmitter 11, uppermost in the diagram, are divided into time intervals, all with the length of T seconds. In the time compression means 42 the signals are compressed during the interval so that they can be sent during approximately T/2 seconds, and in this condition be received in the receiver 25. Compression in time is done by the signals at the beginning of the interval being delayed, in this case by T/2 seconds, while the

signals at the end of the interval remain undelayed. In the time expansion means 53 in the receiver 25, the signals received during the time T/2 are expanded such that once again they take up the time T seconds, now by delaying the last signals in the interval, as will be seen from the chart.

Transmission in the opposite direction from the transmitter 24 to the receiver 12 is described in the lower part of the chart, and the description does not need to be repeated here.

It will be seen from the chart that the utilized single radio speech channel is alternatingly occupied with transmission in one or the other direction. For the transmission to take place alternatingly, the limits between the time intervals in both transmitters are displaced in relation to each other.

As mentioned, time compression is achieved by delaying a part of the speech signals. Such delay can reduce voice intelligibility if it becomes too great. The speech delay will be a certain part of the time interval T, an upper limit thus being set for the length of time interval which may be selected. An interval time of about 100 ms is considered suitable.

When speech signals are to be sent in the described manner on the radio, in about half the time they took to be generated, the signal which is to be transmitted on the radio channel will have twice as high a frequency as the speech signal. The radio channel can involve limitations, so that signals with twice the speech frequency are attenuated, so that when the signal is converted back to normal speed in the receiver the highest frequencies will be lacking, and there is the risk of the voice quality becoming deteriorated.

In an embodiment of the equipment in accordance with the invention, the time compression and time expansion means 42,52,43,53 are arranged with adjustable degrees of compression and expansion, these means cooperating with associated transmitter-receiver switches 41, 51 during the adjustment. Each transmitter-receiver switch is adapted such that when its associated radio transmitter lacks a speech signal for transmission, the switch assigns the major portion of its sending time of the interval T to the other transmitter of the coacting units. The time compression means at this other transmitter is simultaneously caused

to change its degree of compression so that the assigned transmission time will be filled by speech signals. With the adjustable degree of compression there is avoided a large part of the reduction in quality which could accompany time compression.

Two degrees of compression are alternated between in the exemplified equipment, the normal one of somewhat more than 2:1 and another of about 5:4 (and 5:1 for the poorly utilized channel). Other methods of adjustment in the degree of compression are conceivable, e.g. continuous adjustment. A small portion of the transmission time in each time interval is required for sending synchronization signals and signals concerning the change of compression degree.

The mentioned time compression and time expansion devices 43, 53 are implemented with digital microcircuits in the basic version of the equipment, these circuits being part of the state of the art and thus not needing any further description. Between the units 1, 3 the speech signals are sent by radio as digital signals modulated on a carrier wave. For this purpose the radio transmitters 11, 24 are each provided with an analogue-to-digital converter for converting analogue speech signals to digital before time compression. The radio receivers 12, 25 are provided with a digital-to-analogue converter to convert received digital speech signals to analogue after time expansion.

In a development of the equipment in accordance with the invention the radio transmitters 11, 24 are further provided with a digital-to-analogue converter for converting the signals to analogue after time compression, the radio transmission is thus modulated with analogue signals. In this case, the radio receivers 12, 25 are each provided with an analogue-to-digital converter for converting received analogue signals before time expansion. In this case, analogue, time-compressed speech signals are sent by radio; they do not contain such high frequencies as digital signals and will not suffer limitations in the radio channel bandwidth to such a high degree as the digital signals, and the quality of the voice transmission will thus be improved.

In a further development of the equipment in accordance with the invention, the radio receivers 12, 25 are adapted to work according to the homodyne principle. Receivers of such implementation are described in the British Patent

GB-C-1530602, and are therefore not described more closely here. The carrier frequency of each radio transmitter 11, 24 in the equipment is equal to the frequency of a local oscillator in the radio receiver included in the equipment. As mentioned, a single radio call channel for transmission in both directions is used for a pair of the units.

Both the units 1, 3 in a pair are disposed for sending and receiving calls coded for the intended receiver. On delivery, the stationary unit 1 is set for sending and receiving calls containing a given code, while the wireless handset 3 lacks such setting. Both units are provided with connection means and adapted such that, when they are connected to each other for a short while, the setting of send and receive code which is to be used by the wireless unit is transferred from the stationary unit to the latter, where it is stored.

With this arrangement there is achieved that the setting of the wireless telephone handsets to a given code before delivery becomes unnecessary, so that administrative problems in conjunction with their delivery are considerably reduced.

CLAIMS

1 Equipment for wireless transmission of telephone calls, in which there is included a plurality of pairs of coacting units (1, 3) between which telephone calls are to be transmitted, each pair comprising a stationary unit (1) connected to a telephone line (2) and provided with a radio transmitter (11) and a radio receiver (12), the other one of the pair being a telephone handset (3) at a distance from the stationary unit, provided with a radio transmitter (24) and a radio receiver (25), both units each being provided with an array of monitoring circuits (17, 30) and a channel selector (15, 28) for selecting a usable radio speech channel amongst a plurality of such channels common to all pairs of units (1, 3), where

the radio speech channel is a single, selected dedicated frequency band for duplex speech between the units (1, 3) in the pair, and

time-controlled send-receive switches (41, 51) in each of the units are adapted for mutual coaction in a pair of the units for changing transmission direction at short time intervals, and

the radio transmitters (11, 24) are adapted with time compression means (42, 52) for sending speech signals with higher than real time speed, and

the radio receivers (12, 15) are adapted with time expansion means (43, 53) intended to give back the real time speed to the speech signals,

characterized in that each send-receive switch (41, 51) is adapted to distribute send and receive time intervals with a total length for transmission and reception which is constant; and in that the time compression means (42, 52) of each radio transmitter (11, 24) has an adjustable degree of compression, this means being adapted for coaction with the send-receive switch so that when a speech signal is lacking in a transmitter, said means assigns the major portion of its transmission time to the other transmitter of the coacting units, the degree of time compression of this latter unit being caused to change so that the assigned transmission time will be filled by its speech signal.

2 Equipment according to claim 1, characterized in that the radio transmitters (11, 24) for the speech signals are each adapted with an analogue-to-digital converter connected to the time compression means (42, 52), which is provided with digital circuits, and a digital-to-analogue converter connected to said time compression means before the radio transmitter,

in that the radio receivers (12, 25) are each adapted with an analogue-to-digital converter, coupled between the receiver demodulator and the time expansion means (53), which is provided with digital circuits, and a digital-to-analogue converter connected to said time expansion means before the receiver earphone circuits.

3 Equipment as claimed in claim 1, characterized in that the radio receivers (12, 25) are adapted for operation according to the homodyne principle, and that the carrier frequency of each radio transmitter (11, 24) is equal to the frequency of the local oscillator of the radio receiver incorporated in the same unit (1, 3).

Fig. 1

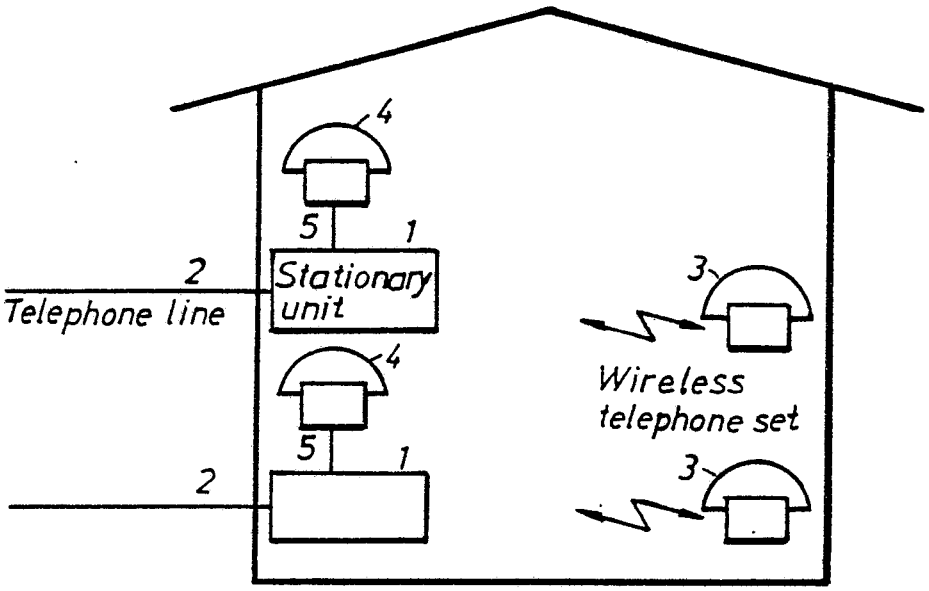


Fig. 2

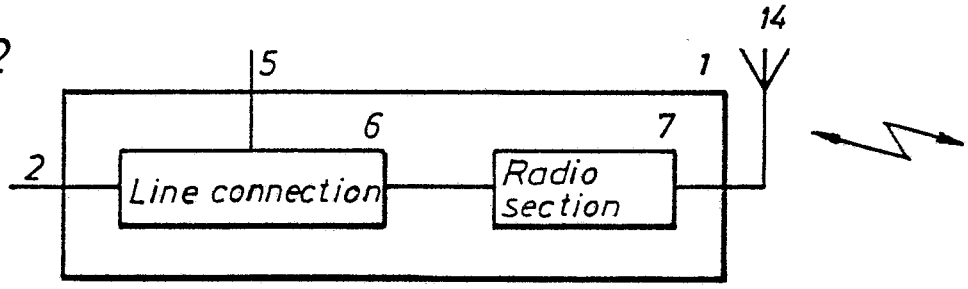


Fig. 3

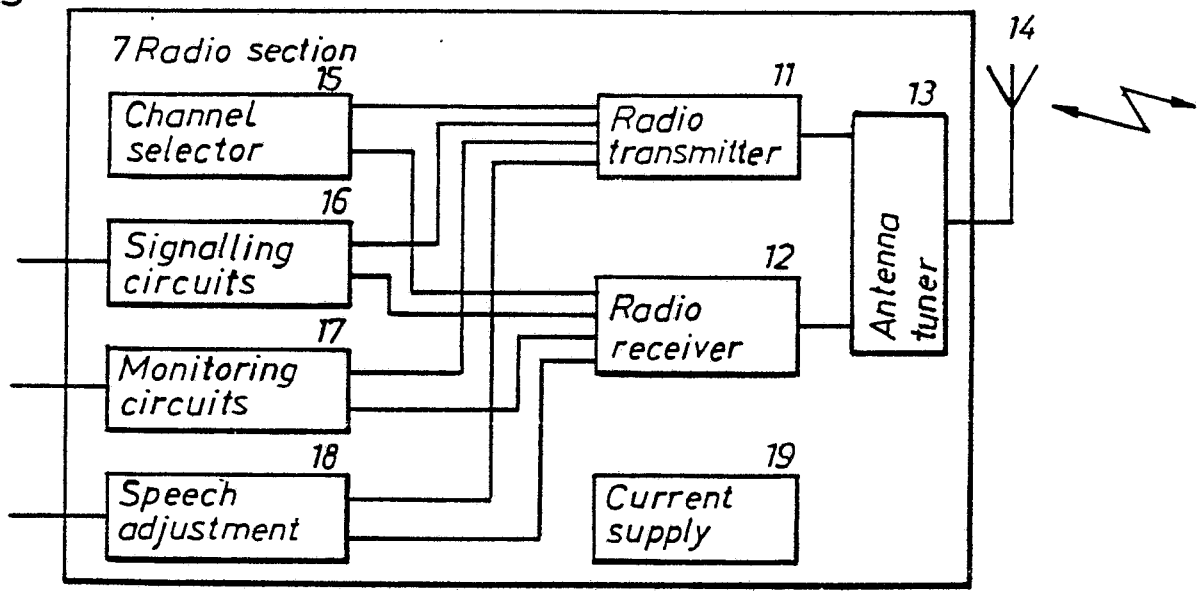


Fig. 4

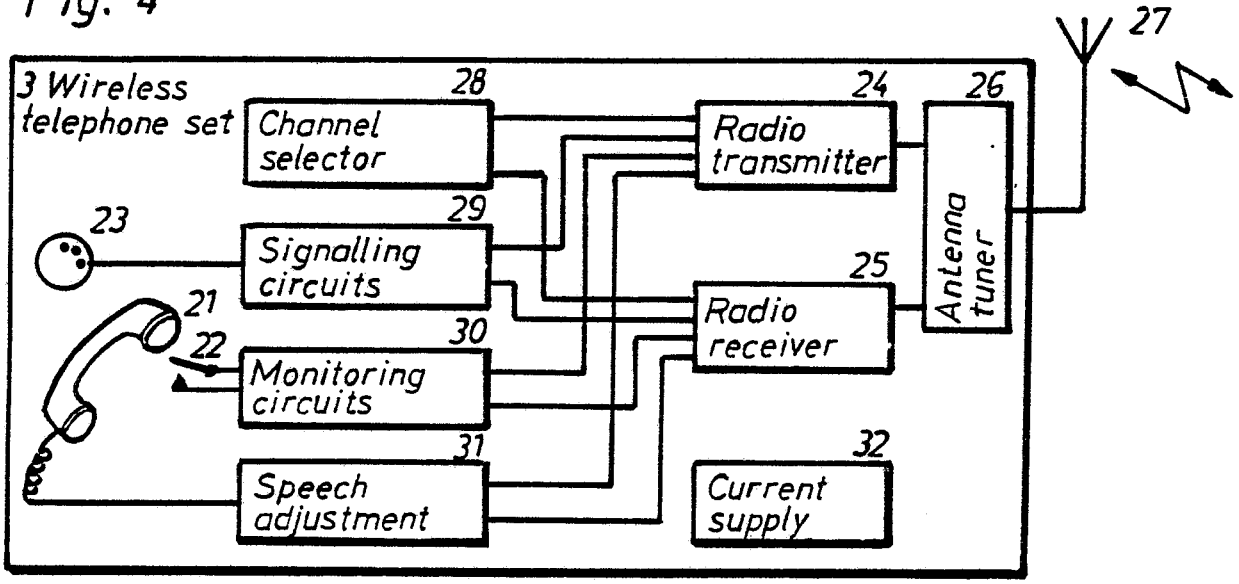


Fig. 5

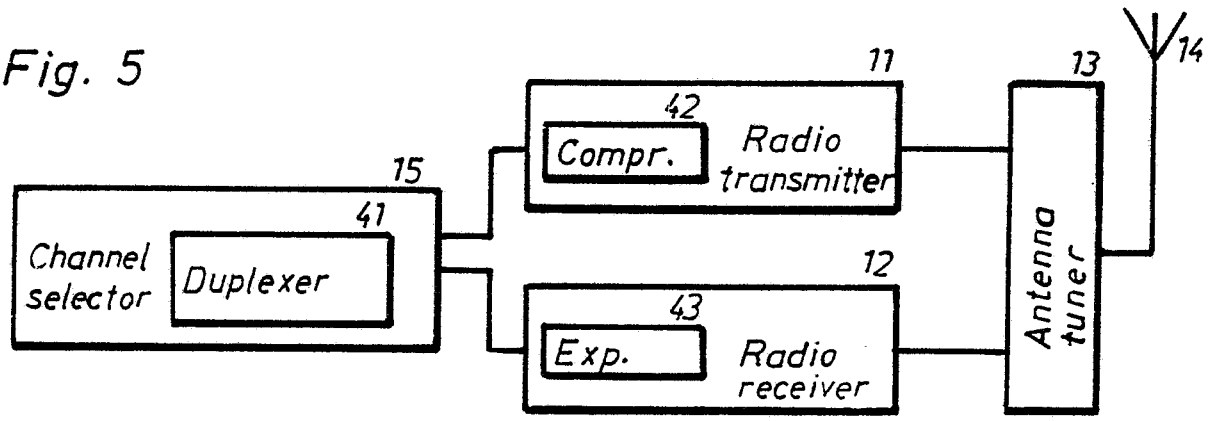


Fig. 6

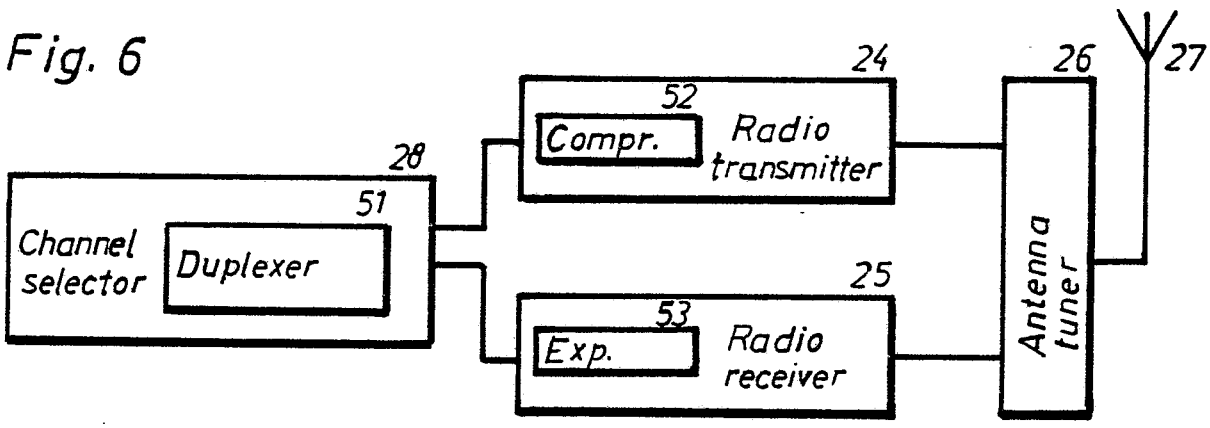
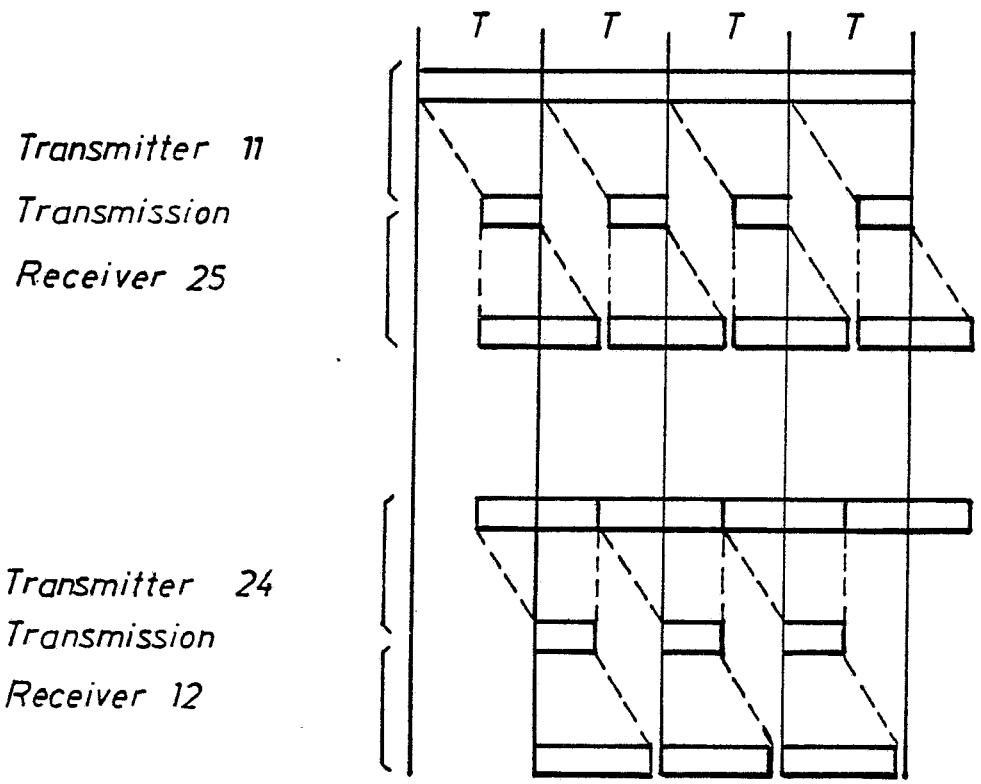


Fig. 7



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE83/00220

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

H 04 B 1/56, H 04 B 7/26, H 04 Q 7/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	H 04 B 1/54,56, 7/24,26, H 04 Q 7/00-04
US Cl	179:2E, 15.5T; 343:175,178

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US, A, 3 827 052 (S TANAKA) 30 July 1974	
A	DE, A1, 2 557 034 (CHIBA COMMUNICATIONS INDUSTRIES, INC) 19 August 1976	
A	GB, A, 2 043 400 (T-C WANG) 1 October 1980	
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