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NOTICE OF ENTITLEMENT

We, ROBERT BOSCH GMBH, of Postfach 30 02 20, 70442 Stuttgart, Germany, in respect of Application No. 10624/95, state the following:-

The person nominated for the grant of the patent has entitlement from the actual inventor by his employment contract with the applicant.

The person nominated for the grant of a patent is the first Applicant of the application listed in the declaration under Article 8 of the PCT.

The basic application listed in the declaration made under Article 8 of the PCT is the first application made in a Convention country in respect of the invention.

DATED this 28th day of June 1996



Colin D. Macauley
Registered Patent Attorney
for and on behalf of the Applicant



AU9510624

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- (56) Prior Art Documents
US 3983484
EP 398688
WO 92/02991
- (57) Claim

1. A radio set which is designed to transmit and receive in an upper and a lower frequency band, wherein the signals to be transmitted and to be received are digital time-division multiplex signals with a system clock modulated on the carrier in the upper and lower frequency range, characterised by

- a first controllable oscillator (1) from whose output signal a system reference frequency is derived by frequency division, which system reference frequency is compared with the system clock of the received signals for the purpose of controlling the frequency of the first controllable oscillator (1), and
- at least one second controllable oscillator (2, 2') is coupled to the first controllable oscillator (1) and can be tuned by intervals determined by a channel pattern,
- wherein the frequencies of the first (1) and the second (2, 2') controllable oscillator are selected so, that a difference of the frequencies results in a transmission frequency in the lower frequency range and a sum of the

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(10) 680964

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frequencies results in a transmission frequency in the upper range.

2. A radio set according to claim 1, characterised in that for the reception an intermediate frequency is formed as the difference of the frequency of the received signal and the frequency of the second controllable oscillator (2, 2').
3. A radio set according to claim 2, characterised in that by forming a difference from the intermediate frequency and the frequency of the first controllable oscillator (1) a further intermediate frequency is produced.



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		(43) Internationales Veröffentlichungsdatum:	8. Juni 1995 (08.06.95)
(21) Internationales Aktenzeichen: PCT/DE94/01413		(81) Bestimmungsstaaten: AU, CN, PL, europäisches Patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) Internationales Anmeldedatum: 29. November 1994 (29.11.94)		Veröffentlicht <i>Mit internationalem Recherchenbericht. Vor Ablauf der für Änderungen der Ansprüche zugelassenen Frist. Veröffentlichung wird wiederholt falls Änderungen eintreffen.</i>	
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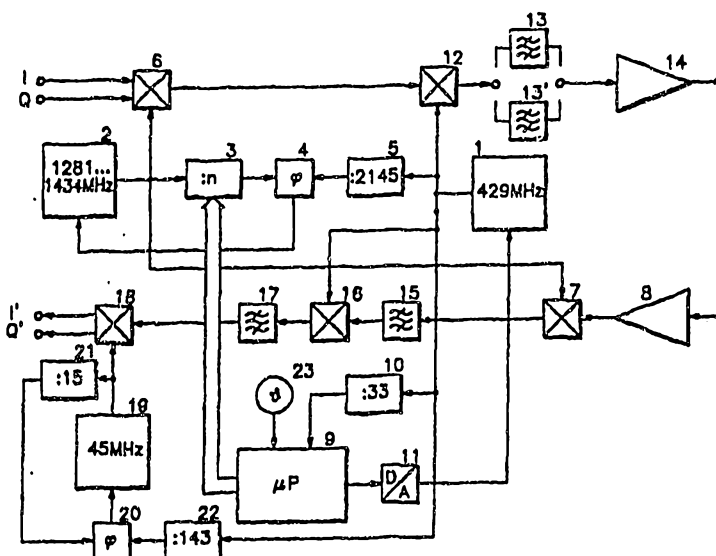
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(54) Title: RADIO SET

(54) Bezeichnung: FUNKGERÄT

(57) Abstract

Described is a radio set designed for transmission and reception in an upper and a lower frequency band, the transmitted and received signals being time-multiplexed digital signals with a frequency timing on carrier waves modulated in the upper and lower frequency bands. The radio includes a first controllable oscillator from whose output signal is derived, by frequency division, a system reference frequency which is compared with the frequency timing of the received signals in order to control the frequency of the first oscillator, and at least one second controllable oscillator which is coupled to the first oscillator and is tuned in steps defined by a channel raster, the frequencies of the first and second oscillators being chosen such that the difference between the frequencies gives a transmission frequency in the lower frequency band the sum of the frequencies gives a transmission frequency in the upper frequency band.



Radio set

The invention is based on a radio set of the type mentioned in the main claim.

5 Various standards have become known for radio networks wherein a great number of transmission channels is produced by frequency and time division multiplexing. In the case of the GSM standard, which is used in the D1 network, frequencies of 10 890 MHz to 915 MHz with a 200 kHz grid are used to transmit from mobile radio stations to base stations and frequencies of 935 MHz to 960 MHz also in the 200 grid kHz to transmit from the base stations to the mobile stations. For a newer standard, the DMCS 1800, frequencies between 1710 MHz and 1785 MHz or 15 1805 MHz to 1880 MHz are also provided with a channel spacing of 200 kHz.

Due to the time division multiplex transmission within the individual channels limited by the carrier frequency an 20 accurate clock and frequency preparation in the radio set is required both at the transmitting and the receiving ends.

The object of this invention is to develop the frequency and clock preparation in a radio set with the least possible number 25 of components in such a manner that for various frequency ranges, particularly for those of the GSM standard and of the DMCS 1800 standard, the most important components, like, for example, oscillators or filters, have the same design.

30 This objective is achieved for a radio set according to the invention by the measures specified in the characterising part of patent claim 1.

35 The radio set according to the invention has the advantage that for both frequency ranges the same oscillators and the circuits associated with them can be used.



A development of the radio set according to the invention is that for the reception an intermediate frequency is formed as the difference of the frequency of the received signal and the frequency of the second controllable oscillator. This makes it feasible to use the same selection means in the receiving part also.

In case of this development it could be preferably provided that by forming a difference from the intermediate frequency and the frequency of the first controllable oscillator a further intermediate frequency is produced. This has the advantage that a subsequent demodulation can be carried out with a relatively low frequency. The signal will be preferably quadrature modulated with the further intermediate frequency, while a reference carrier necessary for the quadrature modulation is produced by a third controllable oscillator, which is coupled to the first controllable oscillator.

Another development of the invention is that the second controllable oscillator can be controlled with the aid of a phase comparison circuit, to which the output signal of the first controllable oscillator divided with regard the frequency by a first frequency divider and the output signal of the second controllable oscillator divided with regard the frequency by a second frequency divider can be supplied. Preferably the divider ratio of the second frequency divider can be controlled.

By this development a simple selection of the radio channel is feasible by setting the divider ratio with the aid of a microprocessor which also controls other functions of the radio set. For this reason the signals which have been divided with regard the frequency and can be supplied to the phase comparison circuit have a frequency corresponding to the channel pattern.

In case of a radio set according to the invention the second controllable oscillator can be used both for transmission and



reception. The frequency required for the respective time slot to transmit and to receive is then set by a corresponding adjustment of the frequency divider by the microprocessor. Depending on the prerequisites in each individual case,
5 according to a further development of the invention for transmission and reception a second controllable oscillator each can be provided with a phase comparison circuit and a second frequency divider for each case.

10 An advantageous development of the invention is in that for the control of the frequency of the first controllable oscillator, a microprocessor, by comparing the system clock of the received signal and the system reference frequency and by measuring the temperature, produces a control signal for the first
15 controllable oscillator, which signal can be supplied to the first controllable oscillator via a digital/analog converter. In this manner an excellent stability of the frequency of the first controllable oscillator can be achieved.

20 Corresponding to the GSM standard and the DMCS 1800 standard a further advantageous embodiment with a lower frequency range of 890 MHz to 915 MHz for transmission and of 935 MHz to 960 MHz for reception and with an upper frequency range of 1710 MHz to 1785 MHz for transmission and of 1805 MHz to 1880 MHz for
25 reception and with a system clock of 13 MHz provides that the frequency of the first controllable oscillator is an integral multiple of 13 MHz, preferably the 33-fold multiple.

Embodiments of the invention are illustrated in the drawing
30 based on several figures and explained in detail in the following description. Shown is in:

Fig.1 - a block circuit diagram of a first embodiment, and

35 Fig.2 - a block circuit diagram of a second embodiment.

In the figures the same parts are designated with the same reference numerals. The figures illustrate those parts of a



radio set which are necessary for the explanation of the invention, while further devices, like, for example, operating devices, the processing of low frequency signals and the control necessary for the time division multiplex technique are not shown in detail for clarity's sake.

In the radio set illustrated in Fig.1 a first controllable oscillator 1 is provided operating with a fixed frequency of 429 MHz. This is the 33-fold multiple of 13 MHz, namely of the system clock established by the GSM standard.

A second controllable oscillator 2 can be tuned in the range of 1281 MHz to 1434 MHz in steps of 200 kHz. The oscillator 2 is coupled to the oscillator 1 via an adjustable frequency divider 3, a phase comparison circuit 4 and a fixed frequency divider 5, and it supplies a carrier signal for a modulator 6 to which the modulation signals *I* and *Q* can be supplied in a manner known per se in the transmitting part and for a mixer 7 which receives signals received by an antenna (not illustrated) via the amplifier 8 in the receiving part.

The divider ratio *n* of the frequency divider 3 can be adjusted between 6405 and 7170 with the aid of a microprocessor 9. By dividing the frequency of the oscillator 1 in 5 the phase comparison is carried in 4 with signals the frequency of which is 200 kHz. Due to this an increments of the divider factor *n* represent a frequency jump of 200 kHz.

A coupling of the output signal of the oscillator 1 with the system clock contained in the received signals is carried out with the aid of the microprocessor 9, to which the output signal of the oscillator 1 is supplied via a frequency divider 10 and which microprocessor conveys a control signal to the oscillator 1 via a digital/analog converter 11. In the case of radio sets of suitable types the microprocessor 9 receives in a manner known per se the demodulated received signals, from which it derives the system clock for the purpose of a



comparison with the system reference frequency produced by the frequency divider 10.

5 After mixing the signals *I* and *Q* with the output signal of the second oscillator 2 a further mixing is carried out in 12 with the output signal of the oscillator 1. Depending on whether the radio set is to be used in a GSM network or in a 1.8 GHz network, a band filter 13, 13' is connected to the output of the mixer 12. Afterwards in 14 an amplification of the signals
10 is carried out which are then fed to the antenna.

After the mixing in 7 with the output signal of the oscillator 2 an intermediate frequency of 474 kHz is filtered out from the mixed product on the receiving side with the aid of a band
15 filter 15, which intermediate frequency is mixed subsequently in 16 with the frequency of the oscillator 1. The mixed product is conveyed through a band filter 17, so that a second intermediate frequency of 45 MHz is produced. This is demodulated in a quadrature modulator 18 from which the signals
20 *I'* and *Q'* can be obtained. A carrier of also 45 MHz required for the quadrature modulator 18 is produced with a third controllable oscillator 19, which with the aid of a phase comparison circuit 20 and two frequency dividers 21, 22 is coupled to the oscillator 1.

25 For the transmitting frequencies lying on the band limits the frequency of the oscillator 2 is to be set as follows:

30 1319 MHz - 429 MHz = 890 MHz
1344 MHz - 429 MHz = 915 MHz
1281 MHz + 429 MHz = 1710 MHz
1356 MHz + 429 MHz = 1785 MHz

35 For the reception of the frequencies lying on the band limits the following settings of the oscillator 2 are necessary, resulting in the same intermediate frequency of 474 MHz in each case:



$$\begin{aligned}
 1409 \text{ MHz} - 935 \text{ MHz} &= 474 \text{ MHz} \\
 1434 \text{ MHz} - 960 \text{ MHz} &= 474 \text{ MHz} \\
 -1331 \text{ MHz} + 1805 \text{ MHz} &= 474 \text{ MHz} \\
 -1406 \text{ MHz} + 1880 \text{ MHz} &= 474 \text{ MHz}
 \end{aligned}$$

5

In the frequency control of the oscillator 1 with the aid of a microprocessor 9, of the frequency divider 10 and of the digital/analog converter 11 a temperature compensation can be also included, wherein based on the temperature measurement the microprocessor influences the control signal in an appropriate manner via a sensor 23.

In the case of the radio set according to Fig.1 the oscillator 2 is switched over between the frequencies required in each time for the transmission and reception. This is feasible since in the suitable systems (e.g. GSM standard) the time slots for transmission and reception are shifted in time relative to each other.

However, in the case of the embodiment according to Fig.2 a second oscillator 2, 2' is provided for transmission. In a corresponding manner two controllable frequency dividers 3, 3' and two phase comparison circuits 4, 4' are also provided. Otherwise the embodiment of Fig.2 corresponds to that of Fig.1.

The invention is not limited to the frequencies specified in the embodiment. Thus, for example, multiples of 13 MHz other than 33 can be produced in the oscillator 1; 416 MHz, 390 MHz or 351 MHz, for example. In this case the values of 71 MHz, 90 MHz or 133 MHz will result for the second intermediate frequency.



Claims

1. A radio set which is designed to transmit and receive in an upper and a lower frequency band, wherein the signals to be transmitted and to be received are digital time-division multiplex signals with a system clock modulated on the carrier in the upper and lower frequency range, characterised by

- a first controllable oscillator (1) from whose output signal a system reference frequency is derived by frequency division, which system reference frequency is compared with the system clock of the received signals for the purpose of controlling the frequency of the first controllable oscillator (1), and
- at least one second controllable oscillator (2, 2') is coupled to the first controllable oscillator (1) and can be tuned by intervals determined by a channel pattern,
- wherein the frequencies of the first (1) and the second (2, 2') controllable oscillator are selected so, that a difference of the frequencies results in a transmission frequency in the lower frequency range and a sum of the frequencies results in a transmission frequency in the upper range.

2. A radio set according to claim 1, characterised in that for the reception an intermediate frequency is formed as the difference of the frequency of the received signal and the frequency of the second controllable oscillator (2, 2').

3. A radio set according to claim 2, characterised in that by forming a difference from the intermediate frequency and the frequency of the first controllable oscillator (1) a further intermediate frequency is produced.

4. A radio set according to claim 3, characterised in that the signal is quadrature modulated with the further intermediate frequency, while a reference carrier necessary for the quadrature modulation is produced by a third



controllable oscillator (19) which is coupled to the first controllable oscillator (1).

5. A radio set according to any one of the preceding claims, characterised in that the second controllable oscillator (2, 2') can be controlled with the aid of a phase comparison circuit (4, 4'), to which the output signal of the first controllable oscillator (1) divided with regard the frequency by a first frequency divider (5, 5') and the output signal of the second controllable oscillator (2, 2') divided with regard the frequency by a second frequency divider (3, 3') can be supplied.
6. A radio set according to claim 5, characterised in that the divider ratio of the second frequency divider (3, 3') can be controlled.
7. A radio set according to claim 6, characterised in that the signals which have been divided with regard the frequency and can be supplied to the phase comparison circuit (4, 4') have a frequency corresponding to the channel pattern.
8. A radio set according to any one of the claims 6 or 7, characterised in that for transmission and reception a second controllable oscillator (2, 2') each is provided with a phase comparison circuit (4, 4') and a second frequency divider (3, 3') for each case.
9. A radio set according to any one of the preceding claims, characterised in that for the control of the frequency of the first controllable oscillator (1) a microprocessor (9), by comparing the system clock of the received signal and the system reference frequency and by measuring the temperature, produces a control signal for the first controllable oscillator (1), which signal can be supplied to the first controllable oscillator (1) via a digital/analog converter (11).



10. A radio set according to any one of the preceding claims having a lower frequency range of 890 MHz to 915 MHz for transmission and of 935 MHz to 960 MHz for reception and with an upper frequency range of 1710 MHz to 1785 MHz for transmission and of 1805 MHz to 1880 MHz for reception and with a system clock of 13 MHz, characterised in that the frequency of the first controllable oscillator (1) is an integral multiple of 13 MHz, preferably the 33-fold multiple.



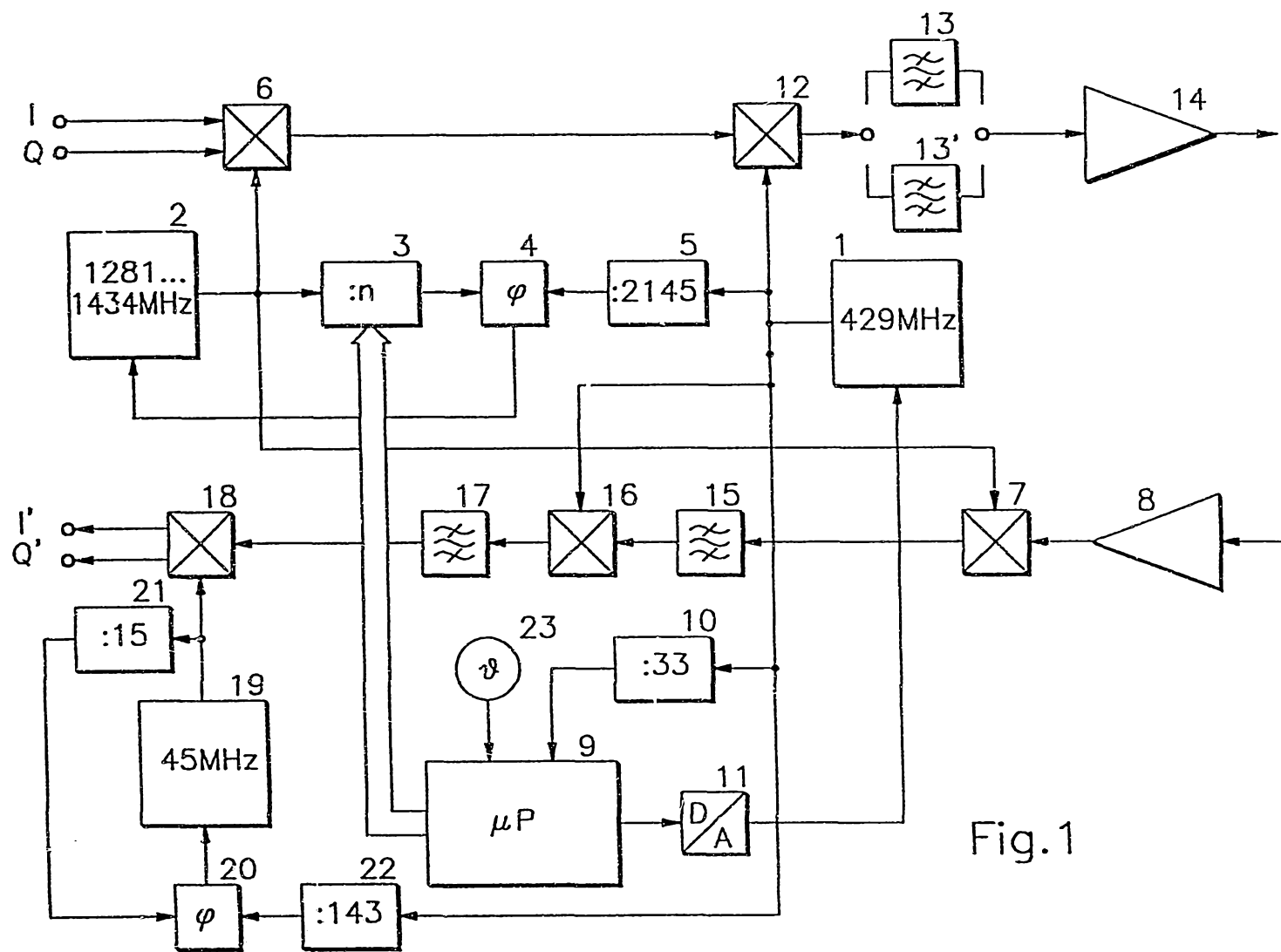


Fig.1

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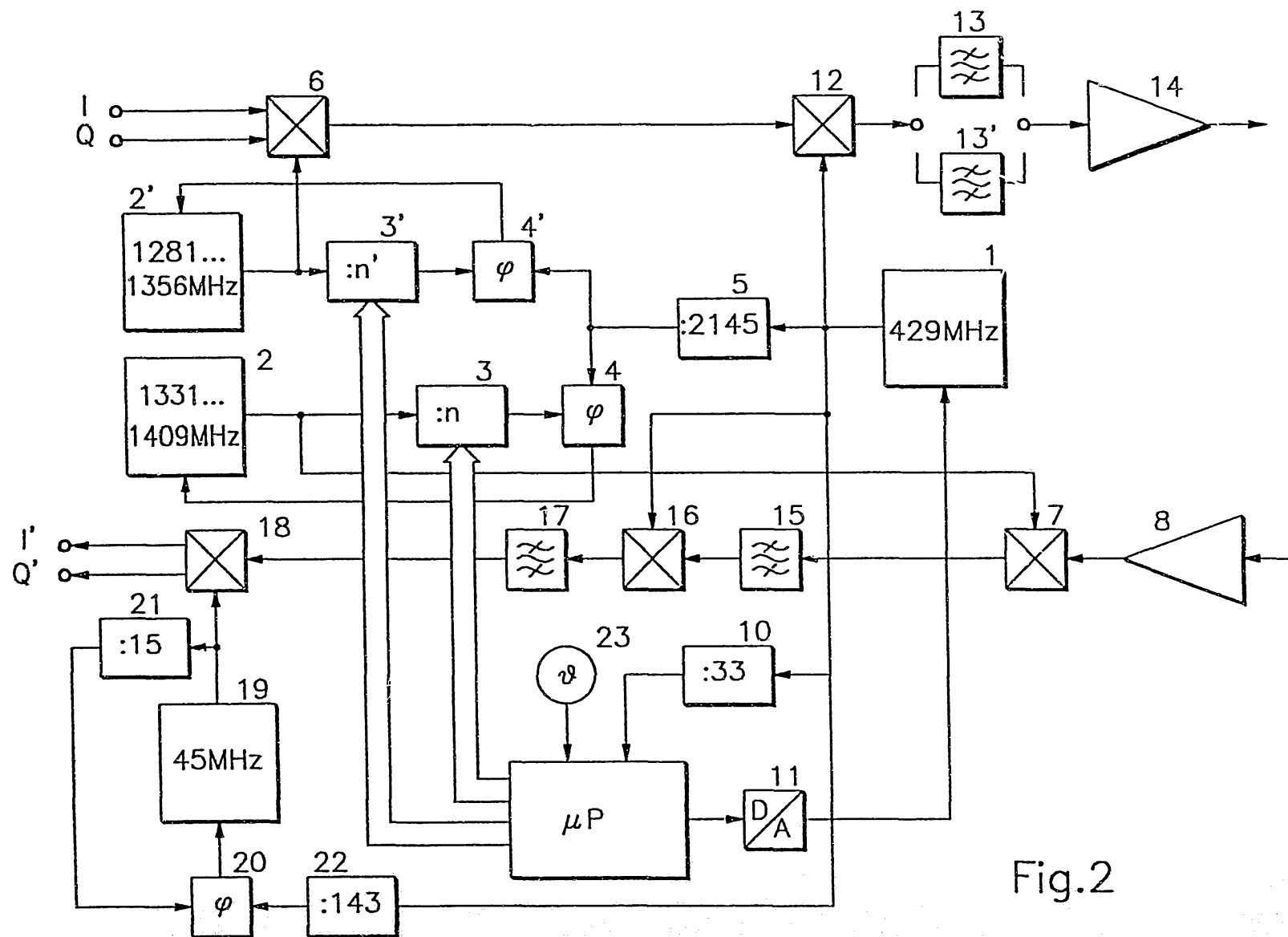


Fig.2

INTERNATIONAL SEARCH REPORT

Internat Application No

PCT/DE 94/01413

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H04B1/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04B H03L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,3 983 484 (TAKUO HODAMA) 28 September 1976	1-3,5-7
A	see column 2, line 50 - column 3, line 66 see column 4, line 15 - line 23 see column 6, line 30 - line 60 ---	4,8-10
Y	EP,A,0 398 688 (NOKIA MOBILE PHONES LTD.) 22 November 1990	1-3,5-7, 9
A	see page 2, line 44 - page 3, line 22 ---	10
Y	WO,A,92 02991 (MOTOROLA INC.) 20 February 1992 see page 3, line 21 - page 4, line 2 see page 6, line 12 - line 19 see page 7, line 14 - line 19 see page 16, line 20 - page 17, line 20 see page 18, line 20 - page 20, line 31 ---	1-3,5-9
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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *B* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

& document member of the same patent family

Date of the actual completion of the international search

8 March 1995

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Internat	Application No
PCT/DE 94/01413	

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US,A,4 802 235 (JAMES E. TREATCH) 31 January 1989 see column 2, line 51 - column 3, line 14 see column 4, line 7 - column 5, line 20 -----	8

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat Application No

PCT/DE 94/01413

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-3983484	28-09-76	NONE	
EP-A-0398688	22-11-90	US-A- 5291474	01-03-94
WO-A-9202991	20-02-92	US-A- 5163159	10-11-92
		AU-B- 655934	19-01-95
		AU-A- 8395091	02-03-92
		FR-A- 2665991	21-02-92
		GB-A, B 2253751	16-09-92
		JP-T- 5502152	15-04-93
US-A-4802235	31-01-89	NONE	